WILDLIFE MANAGEMENT PLAN FOR

ROBERT L. GRAHAM NANTICOKE WILDLIFE AREA

PREPARED FOR

DELAWARE DIVISION OF FISH AND WILDLIFE

AND

DELAWARE FISH AND GAME ADVISORY COUNCIL

BY

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LIST OF TABLES

I. ACKNOWLEDGMENTS

This wildlife management plan is dedicated to the people of the State of Delaware who support the programs such as the Nongame and Endangered Species and Natural Areas Fund, Delaware Natural Heritage, Project Open Space, the Greenways Program, and other public land acquisition programs which preserve and protect the habitat needed for Delaware's wildlife.

I would also like to acknowledge the valuable assistance of other staff members in the Division of Fish and Wildlife who provided data from state wide surveys, especially Greg Moore, Ken Reynolds, Tom Whittendale, Bill Whitman, Cathy Martin, and Craig Shirey. Tom Whittendale wrote the original wildlife management plan for Nanticoke back in 1970 and organized the Ruffed Grouse releases and the Quail Call Count.

I am personally proud of knowing and working with, however briefly, with Mr. Bob Graham, without whom the Robert L. Graham Nanticoke Wildlife Area might be another housing project. As a Wildlife Biologist early in my career, I think I can imagine how hard it must have been carving out a place on the map for a new Wildlife Area. I hope this Plan will help realize that dream.

II. PURPOSE OF PLAN

The purpose of this plan is to develop a written plan of long and short term goals which integrates the management of renewable natural resources on the Robert L. Graham Nanticoke Wildlife Area. The Nanticoke River Basin will be developed at an increasing rate in the next decade. As water, air, and habitat quality diminish, the need for a regional land use plan with meaningful environmental protection will become more apparent. Although Redden and Ellendale State Forests and Trap Pond State Park offer opportunities for wildlife related recreation, Nanticoke Wildlife Area is the only public land on the watershed expressly managed for wildlife. Its future and ability to sustain the increased demand for outdoor recreation will depend on a written plan designed to anticipate the conflicts of human and animal use of habitat.

III. GENERAL MANAGEMENT OBJECTIVES AND GOALS

1. Greater emphasis on the management of upland animals.

2. Create a better balance of habitat types.

3. Establish an improved inventory system for plants and animals. Use faunal and floral surveys done by the Delaware Natural Heritage Program to avoid duplication.

4. Improve the hunting program.

5. Plan for a shift of "user" needs.

6. Update and improve the methods of surveying the people who use the area.

IV. DESCRIPTION OF AREA

A. General.

Robert L. Graham Nanticoke Wildlife Area is located in the southwest corner of Delaware on the eastern shore of the Nanticoke River at its confluence with the Broad Creek (formerly Laurel Creek). The Wildlife Area lies on the north and south banks of Broad Creek in three parcels. The habitat is wooded (89 %) and interspersed with small fields and interior access roads (Table 1). Nanticoke Wildlife Area contains a total acreage of 2006.838 acres as of 10/18/90 (Smith 1990).

The largest and most intensively used portion of the Area lies to the south of the Broad Creek on both sides of Phillip's Landing Road (County Road 496) and to the north of the Sharptown Road (County Roads 494). The HENRY/HASTINGS Tract is primarily wooded while containing 15 Wildlife Food and Cover Plots.

Two dirt access roads traverse (and help define) this tract - one on the eastern boundary (Eastern Boundary Road) and the other through the heart of the tract (Main Road). The largest fields on the area occur at the old George Adam's Farm (31.3 of 58 acres). A row of large old American sycamores (Platanus occidentalis)and a family cemetery suggest the location of the old farm. The Headquarters is located in a fenced compound along the Sharptown Road (C. R. 494). A garage and pole barn are the only structures on the Area. A wooden bulletin board with a hipped cedar shake roof and a large entrance sign front the area along C R. 494 1/4 mile west of the headquarters.

Most people know Nanticoke Wildlife Area as Phillip's Landing (sometimes even as Phillip's Landing State Park!) attesting to the popularity of the fishing access area at the terminus of County Road 496. Two boat ramps, a floating pier, 50 parking spots, and picnic facilities provide recreational access to the Nanticoke/Broad Creek Watershed. Phillip's Landing Recreation Access Area lies within the HENRY/HASTINGS Tract of the Wildlife Area.

The second largest parcel (533.6 acres) lies north of the Broad Creek extending from Bailey's Landing to the west to the east bank of the Nanticoke River. This area is called "RED HOUSE" for an old house on the Phillip's tract which is no longer present. The Laurel Sportmans' and Beagle Club lies along the Red House Road on the eastern boundary of this property. The tract is wooded and surrounded by more forest managed for timber and pulpwood by the Chesapeake Corporation of Virginia. Dirt access roads run along all the boundaries on the RED HOUSE tract.

The third tract of Nanticoke Wildlife Area (59.7 acres) lies one mile south of the Broad Creek/Nanticoke River confluence on the eastern shore of the Nanticoke River just south of

Prickley Pear Island. This disjunct parcel was bought to protect a native American prehistoric site and the site can only be entered across private property. The site is an upland hummock surrounded by wet woods. The Maryland/Delaware state line crosses the river less than a quarter of a mile downstream from Prickley Pear Island.

Table 1. Habitat types at Nanticoke.

HABITAT	AREA (AC)	(%)
FORESTED	1798.9	89.6
FOOD PLOTS	57.2	2.8
OTHER	150.7	7.6
TOTAL	2006.8	100.0

B. Past Conditions.

1. Prehistoric

A recent publication (Custer and Mellin 1989) describes an archaeological survey of prehistoric Native American artifacts on the Nanticoke watershed. Several of the sites occurred on the Nanticoke Wildlife Area. The authors describe in detail their survey methodology and results. I have written a brief synopsis of time frames, the terminology, and how the Indians' interaction with their "habitat" influenced site locations found on the present day Wildlife Area.

Paleo - Indian Period (12,000 B. C. - 6,500 B. C.)

The Post-Glacial Episode was characterized by a deciduous gallery forest along the Nanticoke dotted with some floodplain grasslands. The well-drained sites away from the river were vegetated with a boreal forest and limited grasslands. The low-lying areas were boggy or deciduous swamps. Paleo-Indians were big game hunters who lived in small base camps along the Nanticoke River and used large projectiles and scraping tools to kill and prepare megafauna for food and hides. No known Paleo-Indian sites were found on the Area.

Archaic Period (6,500 B. C. - 3,000 B. C.)

These Indians lived during the Pre-Boreal to Atlantic Episodes when the warmer, drier climate caused habitat succession to move from a boreal forest towards a more mesic deciduous forest. The huge animals were replaced by deer-sized animals and the people became more hunter-gatherers than strict hunters. This reliance on the collection of seasonally available wild plants and

animals caused more movement, but the base camps were still used. No Archaic Period Indian sites occur on Nanticoke Wildlife Area.

Woodland I Period (3,000 B. C. - 1,000 A. D.)

The climate continued to warm during the Woodland I Period, but became drier than the preceding period, causing the forests to move towards a oak-hickory complex, more grasslands, a rise in waterlevels and the formation of more tidal marshes. As wild plants such as rice became a staple of their diet, lifestyles became more sedentary and settlements became more densely populated and permanent. More storage vessels were made to store surplus crops. Traders from other tribes brought exotic materials for tools and introduced new stone and ceramic styles. Procurement sites (places where they lived primarily to exploit a locally abundant food source such as mussels or rice) evolved from temporary sites to more permanent year-round sites called base sites. At least 3 sites of each type were identified on Nanticoke Wildlife Area from the Woodland I Period. Each are along the Nanticoke River, the Broad Creek and the confluence of another smaller tributary like Cod Creek. There is some evidence that the locations of base camps moved upstream during the Woodland I Period perhaps as a result of rising water levels or an influx of migrants.

Woodland II Period (A. D. 1,000 - 1,650 A. D.)

The climate was evolving towards the present day conditions during the Woodland I Period and continuing into the Woodland II Period. A Oak-Pine forest with mixed mesophytic plants grew on the well-drained interior sites and a fringe marsh bordered a deciduous gallery forest along the rivers.

In other parts of the country agriculture became more prevalent during the Woodland II Period, but wild plants remained the staple in southern Delaware and settlements changed more slowly. Settlements were very active in the Broad Creek/Nanticoke River area during this period. More upstream sites were established and the downstream sites became more established.

Contact Period (A. D. 1650 - A. D. 1750)

Little is known of the Native Americans living in this area during this time frame. The local people associated little with Europeans, but were dominated by the Susquehannocks of Pennsylvania. Only one site in Delaware is known to represent this time period. No Contact Period sites are known on the Area.

2. Historic - Land Acquisitions

Two and a half acres of land at what is now Phillip's Landing Recreation Area was leased by the Hasting's family to the State of Delaware for recreational purposes in 1960. Shortly after that time, the Commission of Fish and Game Commissioners started negotiating to purchase surrounding land to create a wildlife preserve. The first parcel of land to be purchased for what would come to known as the Robert L. Graham Nanticoke Wildlife Area was a mere 135 acres of flooded woods west of Phillip's Landing at the mouth of Broad Creek. It was purchased from the

estate of Katherine C. Barr through the Sussex Trust Company in June 1967. Almost two years later Delaware Wildlands, Inc. gave 40 acres of land as a gift to the State of Delaware (Table 2).

The first large parcel of land purchased for the Wildlife Area was the Ruth L. Henry Tract (750 acres) in June 1969 Six years of negotiations preceded this purchase. Robert L. Graham, then a Wildlife Technician for the Delaware Board of Fish and Game Commissioners, went to Philadelphia determined to complete the deal for the people of Delaware and the Division. To everyone's surprise, except, I'm sure, Bob's, he returned with a purchase agreement. For his efforts and leadership, the Nanticoke Wildlife Area was renamed in October 1988 to the Robert L. Graham Nanticoke Wildlife Area.

The last major purchase of land in April 1970 secured Phillip's Landing as well as 737 acres of wildlife habitat for the people of the State of Delaware. The land was purchased from Harley and Minnie Hastings. Additional purchases of lands surrounding Nanticoke Wildlife, some of which represented inholdings are listed in Table 2. The Good Tract was made with the assistance of Delaware Wildlands, Inc. to protect a rare plant site.

A land swap was recently negotiated (Spring 1990) with the Stringer family who had an option to buy Norris Niblett's property to exchange land fronting County Road 493-A (2 1/2 acres) for 18 acres of palustrine wooded wetlands on the south bank of the Broad Creek just downstream from the Edward Koch Fishing Access Area. That negotiation has more recently broken down. In October 1990 an outright purchase of the land from Norris Niblett was completed. The upland portion of this area was timber harvested around five years ago (1985) and is now growing in small pines. The remainder of the property is an extensive wooded palustrine freshwater wetland along Broad Creek. The purchase price of $75,000 ($10,000 less than the appraised land value) for 38.58 acres was a good deal. The negotiations and sale were completed by Joan Brown in the Division of Parks and Recreation and assisted by Ron Smith, Property and Acquisition Manger.

The Delaware Office of the Nature Conservancy has expressed an interest in acquiring land held by the Chesapeake Corporation of Virginia near the RED HOUSE Tract. If the sale is made, the Division of Fish and Wildlife could be offered the option to buy from the Nature Conservancy.

Another 97 acres of forested land on the Red House Tract and owned by the the estate of William Phillips may be acquired in the near future. During a meeting with Mrs. Jean Henry (an heir) on September 7, 1990 the Henry's spoke favorably of giving the Division of Fish and Wildlife a first option to buy (the Division now holds a signed first option to purchase). This tract would complete the land holdings to the water at the site of the old Red House, which is located at the terminus of the dirt access road running past the Laurel Beagle Club.

Three family cemeteries are located on the Wildlife Area. The Phillip's Family has a cemetery at Phillip's Landing south of the parking lot. Mr. Marshall Phillips recently repaired broken headstones and requested that the area be secured with a gate. The gate was installed in July 1990. The Adam's Family cemetery is located at the George Adam's Field beside the old home-site. A third graveyard was located on RED HOUSE tract on the north bank of Broad Creek approximately 1/2 mile downstream from Bailey's Landing. The site has a wrought iron fence and six - ten headstones. The lettering on the stones is illegible making identification difficult.

Table 2. Acquisition history at Nanticoke Wildlife Area - 1967-90.
- date of acquisition, former owner's name, cost, size of parcel.

DATE	NAME	COST ($)	ACRE	DEED #
06/16/67	Barr	17000.00	135.000	621-662
06/27/69	Henry	100000.00	750.000	643-552
05/09/69	Del. Wildlands	1.00	40.000	642-274
04/13/70	Hastings	189700.00	737.000	653-98
07/02/71	Phillips	24500.00	103.809	700-97
05/27/75	Gordon	21520.85	43.042	648-235
08/21/75	Wilson	15000.00	21.326	755-15
11/10/75	Atkins	33300.00	52.000	765-222
08/20/81	Del. Wildlands	20497.00	40.081	1077-1
08/20/86	Good	45000.00	46.000	
10/18/90	Niblett	75000.00	38.580	
TOTAL		541518.85	2006.838	

C. Ecological History.

Although the present forest is mixed conifers and hardwoods, soil analysis indicates that the original dominant vegetative type was hardwoods (Ireland and Matthews 1974). Except along the creek and river, the soils are high in calcium. Hardwoods contribute calcium, and other base elements during leaf drop. Pure hardwood stands usually have high soil calcium and base counts. Sussex County soils are low in bases indicating that although there were many hardwoods contributing bases, there were also pines present to utilize them. This ratio shows that pines were present historically, but not at the current levels (Ireland and Matthews 1974). A pulp and sawlog industry has developed a market for pines in Sussex County. Market demand is influencing the composition of the County's forests from hardwoods to softwoods. Whitecedar falsecypress (Chamaecyparis thyoides) was logged extensively along the Nanticoke River. Remnant stands of white-cedar (as it is known locally) occur on the river near Phillip's Landing. Baldcypress is found upstream on the Broad Creek Watershed at Trussum's Pond. No Baldcypress has been found on the Wildlife Area.

Hardwoods were probably harvested for charcoal, building materials, barrels, and railing during the last century. The ship building industry centered along Broad Creek undoubtedly had some influence on the composition of the forest around Little Creek Hundred. Many old growth stands of oak and pine would have been harvested.

The Phillips and Hasting families farmed the area until it was sold in the late 1960's. Most of the present wildlife food and cover plots were farmed by the previous owners. The largest field on the area was farmed by the Adam's family. Much of the forest is third or fourth growth. I suspect that much of the Area was farmed prior to the Phillip's and Hasting's.

D. Geology

Parent material for Sussex County soils is sedimentary in nature. The material was transported by alluvial sources and glacial meltwater run-off. Most of the soils are sandy or clay with very little rocky material present. The soils were deposited in a shallow inland sea which later become the Delmarva Peninsula (Ireland and Matthews 1974).

E. Topography

Nanticoke Wildlife Area lies within a coastal plain ecosystem with gentle slopes rising only a few feet per mile. The highest elevation in the County is 78 feet found to the west along the southern boundary of Delaware near Whitesville. The lowest point on the Area is 10 feet above sea level along the Nanticoke River near the Maryland state line.

Slight differences in elevation have a strong influence in plant communities and soil types. Even though local differences in elevation are slight, they have a strong influence on natural drainage. Most of the poorly to very poorly drained soils are in slight depressions and only slightly lower in elevation than nearby well-drained soils (Ireland and Matthews 1974).

F. Climate

Nanticoke Wildlife Area has a temperate, humid climate typical of most coastal areas in the Middle Atlantic States.
Mean temperature in January is 36 degrees Fahrenheit (F) and 76 F in July. The highest humidity occurs during the month of July (66 %). An average of 49.8 inches of precipitation falls during the year. Snow accounts for only 18 inches of the 49.8 inches of precipitation.

Nanticoke's weather is modified by the ocean. The humidity is higher, and rain evaporates less quickly. The summers tend to be cooler than more inland areas and the winters milder. The predominate breeze during the winter is northwest and during the summer a southeasterly flow.

G. Water.

The Nanticoke River Basin is Delaware's largest watershed (Ireland and Matthews 1974). The Atlantic/Chesapeake divide occurs to the east of Nanticoke at Whitesville. Water flows to the Chesapeake Watershed at Nanticoke. The upper Nanticoke River and all of Broad Creek are part of a fresh tidal marsh system. The water is fresh to only slightly brackish and tidal fluctuations are less than those found along the coast. Freshwater wetland plants tolerant of tidal fluctuations grow along the banks of the river. Navigation aids are maintained by the Army Corps of Engineers within the 50 foot wide, 12 foot deep channel in both tributaries.

Several small feeder streams flow into the larger streams including the Beaver Dam Branch, Cod Creek, a small creek draining into Broad Creek at Cherry Walk near Phillip's Landing, and an unnamed stream on Red House Tract. Each branch has remnant stands of white-cedar falsecypress.

Several wildlife food and cover plots are poorly drained making spring plowing difficult or impossible. A large portion of the George Adam's Field was taken out of tillage during the spring of 1990 after fertilizer trucks and tractors repeatedly got stuck. A ditch along the eastern boundary road has been consistently wet, but was completely backed up with water in the spring of 1991. Another ditch crossing the main road frequently floods as well as the ditch along Phillip's Landing Road where the main road intersects.

H. Land-Use Types

Farming and new or proposed residential developments surround the wildlife area. Two turf farms were recently established near Bethel. The nearest towns are small and rural. Bethel, an unincorporated town designated as a historical district, was once the center for building sailing vessels. Laurel also has a historical district and the famous Laurel Auction where produce is auctioned to buyers for major food chains on the East Coast.

Several housing developments have been or are being built beside the Area. One, White River Estates, was being built as the Wildlife Area was purchased. Another residential project was started beside White River Estates two years ago. A third as yet undeveloped project called Bailey's Landing is planned for property beside the Laurel Sportsmen and Beagle Club. It has been advertised as a "good investment" with buyers bidding for the right to buy a lot (minimum bid of $50,000). Trailer parks have increased with an influx of retired people and as coastal real estate values escalate. The land surrounding the Wildlife Area is zoned AR-1 for agricultural and residential use. The land nearest Laurel is zoned for general residential use.

Like the rest of the county, this area is primarily agricultural based. In Sussex County 76 % of the land mass is devoted to some type of farming. Wooded areas account for another 17 % of the County's acreage (Sussex County Office of Economic Development 1986).

Until the early part of this century, agriculture was dominated by cash-grain crops and general farming. Since about 1910, the production of truck crops has increased steadily, largely on acreage formerly used for small grain (Ireland and Matthews 1974). Watermelons, cantaloupes, and tomatoes are grown on lands surrounding the Area.

Following the acceleration of the program of drainage improvement, and especially since about 1955, the acreage of tilled crops, chiefly corn and soybeans, has expanded in the western part of the county (Ireland and Matthews 1974). These two crops are grown in fields on the east, south, and west of the ADAM'S Tract, and to the east of the Red House Tract.

Chicken farming (broiler production) is a driving force in the Sussex County economy and very prevalent around the Area. Chicken houses are located on all farms surrounding the Wildlife Area.

The major crop on lands owned by the Chesapeake Corporation of Virginia and surrounding the Red House Tract is pulpwood. The land is droughty and the timber production marginal, but it creates a good buffer to residential growth to the north along Woodland Ferry. Ronnie Hasting, a local developer and member of the Nanticoke River Watershed Advisory Committee, says he has the last developable land on the river - near Woodland Ferry Road to the north of Red House. Residential growth to the north is inevitable.

Phillip's Landing is the only public access point to the Nanticoke River in Delaware which has picnic and boating facilities. Many people using the Area are passing through on the way to Phillip's Landing. Although unguarded and only marginally safe due to heavy boat traffic (and poor water quality), many people swim at Phillip's Landing. The closest state park with camping, picnicking, and swimming facilities is Trap Pond, 7 miles to the east of Laurel.

I. Vegetative Cover.

Nanticoke Wildlife Area represents a typical middle Atlantic coastal plain upland plant community. The Oak - Pine plant community has more xeric species that the more coastal areas. White Oak (Quercus alba), southern red oak (Quercus falcata), loblolly pine (Pinus taeda), and Virginia pine (Pinus virginiana) are the dominant or co-dominant overstory trees in every soil series in the Area with the exception of the tidal habitats.

Virginia Pine forms mixed stands with white and chestnut oak (Q. prinus) on the driest and poorest sites. The oaks dominate on the dry, more fertile soils on the Red House tract and away from water on the Henry tract. Loblolly prevails in mixed stands with sweetgum (Liquidambar styraciflua) and southern red oak on the more moist soils intermediate to the oaks and the riparian zone.

Most of the mesic-xeric woods have an open park-like look. Virginia pine stands have little to no shrub layer. The oak stands have extensive low bush blueberry (Vaccinium angustifolium) shrub layers. The moister soils dominated by loblolly pine and southern red oaks have heavy pepperbush (Clethra alnifolia) shrub layers.

The forest type on all the wet soils is a sweetgum -green Ash (Fraxinus pennsylvanica)-blackgum (Nyssa sylvatica)-persimmon (Diospyros virginiana) association. Green ash and sweetgum dominate in poorly drained bottoms. Blackgum, red maple (Acer rubrum), willow oak (Q. phallos), water oak, (Q. nigra), black cherry (Prunus serotina), mockernut hickory (Carya tomentosa), sassafras (Sassafras albidum), and American holly (Ilex opaca) are codominants or understory species beneath loblolly pines and sweetgums.

Other understory species include sweetbay magnolia (Magnolia virginiana), serviceberry (Amelanchier arborea) and subdominants of the common overstory trees. The shrub layer is represented by highbush blueberry (Vaccinium corymbosum), pepperbush, and rosebay rhododendron (Rhododendron maximum). Common vines include poison ivy (Toxicodendron radicans), green briar (Smilax sp.), and trumpet-creeper (Campsis radicans).

The vegetation within the tidal zone of the river, creek, and smaller tributaries like Cod Creek and Beaver Dam Branch is dominated by Virginia arrow-arum (Peltranda virginica). Pickerel weed (Pontederia sp.), cattail (Typha sp.), and wildrice (Zizania sp.) occur on the flats exposed by low tide. These marshes occur within the tidal mud flats where the water salinity ranges between fresh and slightly brackish. Reed grass (Phragmites communis), swamp rose-mallow (Malva mushceotus), and American bulrush (Scirpus americanus) are also common. Whitecedar falsecypress swamps occur just upstream from tidal marsh.

J. Soils.

Nanticoke has two important soil classes. Both are high in sand content, but differ markedly in water profiles. Evesboro sandy loam is the prevalent soil type in the series at Nanticoke and most of the food plots occur on these sandy loams.

Evesboro soils are droughty. The series is a very deep, excessively drained sandy soil found on the uplands. The surface layer and the subsoil are a loamy sand or sand. Available moisture capacity and natural fertility are low to very low. Evesboro soils are found on gentle slopes making them suitable for crops. The soils warm up early in the spring, are easy to work, and can be worked throughout a wide range of soil moistures. However, lots of fertilizer is needed.

The native vegetation found most often on Evesboro soils are hardwoods and some Virginia Pine and loblolly pine. Evesboro soils are rated as fair for grasses and grains, good for hard and softwood tree species, and not suited to wetland food and cover plants, shallow water developments or ponds. Upland game will do fairly well in this soil series (Ireland and Matthews 1974).

Osier soils are the second most common soil series, but occur much less frequently than Evesboro, and are characterized by water near the surface for long periods of the year. Osier soils are deep, poorly drained, gray, very sandy soils on flats and in depressions. They were formed in sandy sediments. Only a Osier loamy sand is found at Nanticoke. Osier soils are found along natural drainages above tidal influences. Mixed wetland hardwoods, pond pine (Pinus serotina) and loblolly pines are associated with Osier loamy sands. This soil type is rated very severely limited by excessive wetness. Osier soils are rated as poor for grasses and grains, fair for trees, good for shallow-water ponds and excavated ponds. The soil is fairly suited for Northern bobwhites production (Ireland and Matthews 1974).

The third and fourth soil series represented on the area include Tidal Marsh - Fresh and Swamp. All of the soils listed as Tidal Marsh at Nanticoke are fresh to slightly brackish. No saltwater tidal lands exist here. A typical tidal soil profile has a 5 inch clay loam which is high in organic matter, underlain by a silty clay loam, usually 13 inches in depth. From 18 to 93 inches below the subsoil is a sticky and slightly plastic loam that is very low in density and high in organic matter content. The soils are saturated with water. Soil volumes shrink by 30 - 40 percent when dried. Unlike tidal marsh soil which turns extremely acidic when dried only, tidal fresh soils have a low enough sulfur content to be strongly to extremely acidic whether wet or dry due (Ireland and Matthews 1974).

Swamp soils differ only in that there is no daily rhythmic fluctuation of water. Neither soil is suited for farming, or trees, and provides excellent food and cover sources for numerous wetland wildlife species. Swamp soils are represented along the Nanticoke River in the Prickley Pear Island area behind the Tidal fresh soils. Tidal fresh soils are found along both main water courses where the banks do not rise rapidly away from the water.

K. Flood, fire, and other calamity history.

Fire is an integral part of pineland ecology. I know of no major wildfires which have occurred at Nanticoke. Controlled burns are used to retard succession and invigorate grass stands with released nitrogen.

Nanticoke has portions of the low lying tributaries within the floodplain. No major flooding problems are known.

V. WILDLIFE POPULATION STATUS

No harvest records were kept for game animals other than White-tailed deer. The population status for these species will be based on personal observations and where appropriate the Hunter Mail Survey and second hand reports.

A. Wildlife Suitability

Wildlife is a product of the land. Good soils produce above average wildlife populations. Unfortunately the soils of Nanticoke are considered average in fertility. Based on a soil suitability rating in establishing wildlife habitat developed by the authors of the Sussex County Soil Survey, the area is most suited for the management of upland wildlife habitat. Evesboro and Osier soils are rated as fair for upland wildlife. Prospects for developing habitat for woodland wildlife, e.g., white-tailed deer (Odocoileus virginianus), gray squirrels (Sciurus carolensis), raccoons (Procyon lotor) , gray foxes (Urocyon cinereus), and songbirds, are rated as fair on Evesboro soils and not suited on the other three wet soils. Management for openland wildlife, e.g., northern bobwhite, mourning doves (Zenaida macroura), eastern cottontails (Sylvilagus floridanus), woodchucks (Marota monax), striped skunks (Mephitis mephitis), and opossums (Didelphis virginiana) on Evesboro were judged to have a fair chance of success. These ratings are based on a weighted average of the suitability of the plants produced on each soil series. They are not sensitive to habitat patchiness or specialized habitat needs.

The three wet soils, Osier, Swamp, and Tidal are all well suited to management of wetland wildlife species. Each has special attributes and should be managed slightly different. Each are moderated by the presence of water. These areas provide greens earlier than more xeric sites. Wild turkeys, for example, are known to frequent seeps and swamps in the winter and early spring to feed on greens, insects, and floating mast.

B. White-tailed Deer

The White-tailed deer herd on the area appears to be stable and healthy. Deer hunting is permitted during all seasons. Harvest records were not kept separately for the Wildlife Area until 1985. Deer were checked at the Georgetown or Bridgeville Deer Checking Stations and recorded as killed in this grid (a 2 mile square block used at the checking stations to pinpoint the harvest locations of each reported deer).

Hunters report that the deer densities on Nanticoke seem stable in recent years. Three deer were killed from the same stand by three different hunters 1989-90 deer hunting season.
Deer sign is very abundant. Deer were killed from at least some of the ten new deer stands in 1990. Reports of does with twins are common on the area. I feel that the deer herd is healthy. Since several auxiliary roads were gated off, the number of sightings has gone up. Presumably the deer lost to poachers has gone down. No hard data is available and this is only a guess.

C. Upland Game

1. Northern Bobwhite

Northern bobwhites occur on the Wildlife Area. Based on the birds seen and flushed by a small number of hunters using dogs, I would say that a sizable number of quail use the area. Three quail hunters with pointing dogs reported seeing 3, 1, and 2 coveys respectively during hunts at Nanticoke in 1986, 1988, and 1989 (Moore 1990). I performed a limited covey count on November 8, 1990. Three English setters and two people found two coveys of quail in and near the George Adam's Field (2 & 3). More coveys are present, but were not found that day.

2. Wild Turkey

Wild Turkeys (Meleagris gallopavo) are not present on the Wildlife Area at the time of this draft, however I feel it is just a matter of time before birds released nearby arrive. Turkeys were released in the Cypress Swamp (1984) to the east and on Idyllwild Wildlife Management Area near Federalsburg, Maryland to the west (date unknown). A release is planned for Nanticoke in 1991-92. I received a report of a hen turkey sighting on May 25, 1991 which was seen on the Good tract. The large wooded area interspersed with small clearings should be acceptable nesting, brooding, and foraging habitat.

3. Ring-necked Pheasant

No Ring-necked Pheasants (Phasianus colchius) have been seen or heard on the area until the summer of 1990. Two Division employees reported one definite and another probable sighting this summer(1990). Whether these birds are wild or released is not known. The distribution of pheasants in the southern half of the state seems to be strongly correlated with the coastal zone

along the Delaware River. I have heard cocks crowing in the Great Marsh outside Lewes, but never this far south or west. I do not feel a breeding population exists at the present time.

A special released pheasant season was held at Nanticoke in 1970 and possibly afterwards. The one week season, October 10 - 17, 1970 entitled 50 hunters at a time to take one bird per day. One hundred pheasants were released on two days. Two hundred and eight hunters killed 55 birds, wounded 4, and fired 131 times (Whittendale 1970). Presumably none of the released birds lived to establish a wild flock.

4. Ruffed Grouse

From 1969 to 1970, 28 wild-trapped Ruffed Grouse from Massachusetts were released on the Nanticoke Wildlife Area. The researcher, Tom Whittendale (1970) reported in the Nanticoke Wildlife Area Wildlife Management Plan that at " least some " of the released birds had been heard drumming. One brood was reportedly seen. At least one bird was shot illegally the year of the release. To my knowledge no grouse have been seen or heard on the Area within the last five years, however one report of a bird closely resembling a grouse being shot near Woodland Ferry gives some hope to an eventual success. I did not see the bird (which was unbanded indicating that it was not from the original release), but a reliable second-hand description of the bird's broad tail leads me to believe it was a probable sighting.

5. Eastern Cottontail

Eastern Cottontails are present and fairly abundant. The distribution seem fairly uniform from uplands to wet edges.

6. Gray Squirrel

Gray Squirrels are plentiful and occur in every woods on the Area. Mast production was heavy in 1985 and 1986, poor in 1987, and average in 1988, 1989, and 1990.

Nest box use is inconsistent and tells us little about the yearly densities fluctuations. Some years reproduction is fair, other years nonexistent. Adult squirrels use the boxes each year (Table 3). Trap Pond has experienced a "plague" of gray squirrels in the camping areas the past three summers. During the summer of 1989, 30 squirrels were trapped and released at Nanticoke. Hunters reported killing limits (4) of squirrels in very short times. I received (12/4/90) a second hand report from another Division employee of Gray Squirrels swimming across both the Nanticoke River and Broad Creek this summer. At least 4 squirrels were seen and retrieved from the water. I do not know how often this "strange" event occurs or why. Squirrel emigrations (including crossing bodies of water) have been documented (Madson 1964). Madson (1964) speculated that emigrations occur during periods of high population densities.

Table 3. Squirrel nest box utilization data 1986 - 1991.

# # # # # #

	boxes	boxes used	boxes w/ young	boxes w/ young adults		
1986	12	6	4	2	7	9
1987	24	10	3	7	5	15 No July litters
1988	24	6	0	6	0	7
1989	24	2	0	2	0	2 2 Raccoons - May
1990	24	8	8	8	10	8
1991	24	7	0	7	0	17 Screech, opossum

D. FURBEARERS

1. Raccoon

Commercial trapping rights to Nanticoke were leased for $166 in 1988-89, and the trapper caught no raccoons. Affidavits from the trapper who leased the Nanticoke Units 1 & 2 during the 1987-88 trapping season indicate that raccoons are present and abundant. A total of 64 raccoons were trapped along three miles of shoreline.

2. Opossum

No trapping data exists for opossums. Based on the abundance of food and cover and the ubiquitous nature of the animal, I feel that a healthy population density of possums occur on the area.

3. Muskrat(Ondatra zibethicus)

Habitat for muskrats along the Broad Creek and Nanticoke River is ample and of good quality. During the 1987-88 trapping season 169 muskrats were trapped. The area was not trapped in 1988-89, but 60 muskrats were trapped in 1989-90. No attempt was made to obtain trapping effort information, so these numbers are only a rough indication of abundance.

4. River Otter (Lutra canadensis)

Otters are known to travel the waterways of western Sussex County, but I do not know of their presence or absence on Nanticoke.

5. Gray and Red Fox

Both Gray (Urocyon cinereoargenteus) and Red Foxes (Vulpes fulva) are present on the Area. Fox "hunters" chase both species and report that they are present, but at lower numbers than in the past. A red fox den is located in the middle of Field 11 on the HENRY/HASTINGS tract. The preponderance of woods would seem to favor the gray fox over the Red.

6. Eastern Striped Skunk (Mephitis mephitis)

No signs of Eastern Striped Skunks have been seen. The Area is within its range and I feel that the chances are good that skunks occur on the Wildlife Area.

E. Songbirds

The presence and breeding status of endemic songbirds is documented in the Breeding Atlas of Delaware to be published in the spring of 1991. The Division has contributed some data for the Nanticoke Wildlife, but most of the data was collected from private individuals with ornithological experience. Please refer to this publication for a listing of the avifauna of Nanticoke Wildlife Area. A Wildlife Species Checklist contains all the potential songbirds that could be found within the mid-Atlantic States (Appendix 1).

F. Reptiles and Amphibians

No amphibian or reptile species of special concern are known to occur on Nanticoke Wildlife Area. A few limited herpetological surveys have been done for Nanticoke as of 1990. Some common breeding amphibians heard during the springs of 1986, 1987 and 1988 include the green tree frog (Hyla cinerea), gray tree frog (H. veriscolor), spring peeper (H. crucifer), southern leopard frog (Rana utrucularia), bullfrog (R. catesbeiana) and Fowler's toad (Bufo fowlerii). Some turtles seen include: snapping turtle (Chelydra serpentina), eastern mud (Kinosternon s. subrubrum), spotted (Clemmys guttata), eastern painted (Chrysemys p. picta), and the eastern box (Terrapene c. carolina). The red-backed salamander (Plethedon cinereus) is the only salamander I have found on the area.

Fence lizards (Sceloporus undulatus hyacinthinus) and five-lined skinks (Eumeces fasciatus) are the only lizard representatives found on the Area to date.

Snakes found on the area include: eastern garter (Thamnophis s. sirtalis), eastern hognose (Heterodon platyrhinos), southern ringneck (Diadophis p. punctatus), black rat (Elaphe o. obsoleta), northern black racer (Coluber c. constrictor), eastern kingsnake (Lampropeltis getulus) and northern water snake (Nerodia s. sipedom).

There are potentially other amphibians and reptiles that (and probably do) inhabit the Area. Their presence or absence will be recorded in a Wildlife Species Checklist as they are found. (see Appendix 1 for a complete listing).

G. Endangered Species

The following description of endangered species will be limited to those species found on the wildlife area or nearby. Specifically excluded are marine mammals, sea turtles, and the shortnose sturgeon (Acipenser brevirostrum) because the area does not contain suitable habitat for

these species. Tiger salamanders (Ambystoma tigrinum), bog turtles (Clemmys muhlenbergii), and Cope's gray treefrog (Hyla chrysoscelis) could occur here, but have not been located.

1. Bald Eagle (Haliaeetus leucocephalus)

A bald eagle nest just south of the Prickley Pear Island tract has been active for a number of years. Although the nest is in Maryland, aerial surveys by both states have compiled nesting information. Adult birds are seen in the vicinity of Phillip's Landing and in some interior fields during the summer.

2. Osprey (Pandion haliaetus)

Ospreys are common nesters on channel markers along Nanticoke River. No nesting platforms have been erected and no nests are located on duck blinds. This watershed is not surveyed and no reproductive data is available.

3. Hawks

Red-tailed hawks (Buteo jamaicensis) are year round residents and common on the area, but no nesting efforts have been documented. Migrants (and possible nesters) seen on the area include red-shouldered hawks (B. lineatus), kestrels (Falco sparverius), sharp-tailed hawks (Accipter striatus), Cooper's hawk (A. cooperii), and broad-winged hawks (B. platypterus). Merlins (F. columbarius) and northern harriers (Circus cyaneous) are frequently seen in the fall and winter.

4. Owls

The two common species which breed on the area are the Great horned owl (Bubo virginianus), and the eastern screech owl (Otus asio). No horned owl nests have been found, but they can be heard singing each spring and summer. Barn owls might occur in the area, but no singing or nesting records are available. Barred owls (Strix varia) should occur here, but no reports have been received.

I. Waterfowl

Historically these marshes have been recognized as significant breeding sites for black ducks (Anas rubripes), a species of special concern in Delaware, and the blue-winged teal (Anas discors). Today these marshes continue to provide important breeding sites for mallards (Anas platyrhynchos), black ducks, blue-winged teal, gadwall (A. strepera), and wood ducks (Aix sponsa). Large numbers of migrating waterfowl use the wetlands of the Nanticoke in the spring and fall, especially black ducks, blue-winged teal, and wood ducks. To a lessor extent green-winged teal (A. crecca), pintails (A. acuta), widgeons (A. americana), ring-necked ducks (Aythya collaris), common mergansers (Mergus merganser), and Canada geese (Brant canadensis) use the Nanticoke. Species using the Nanticoke in the winter months are black ducks, mallards, and Canada geese (Whitman 1991).

J. Fish

A complete list of the fish occurring within the Delaware portion of the Nanticoke River watershed is listed in Appendix 2.Resident and migratory species mix within the river basin. Yellow and white perch make short seasonal migrations: American shad, blueback herring, hickory shad, alewife, and striped bass are anadromous. Spawning by the following anadromous species occurs within the Nanticoke, although not necessarily within the Delaware portion of the river: alewife, american shad, blueback herring, hickory shad, and striped bass. Several species normally spawn downstream, either in the lower Nanticoke or the Chesapeake Bay, but use the upper watershed as nursery habitat. These species include Atlantic croaker, Atlantic menhaden, as well as the striped bass. Species of commercial importance include herrings, American shad, catfish, white perch, and striped bass.

Largemouth bass is the sportfish of the most importance. Several surveys are in progress to determine relative abundance, population, and spawning areas on the upper watershed. Fishes listed under the Special Status column of Appendix 2 include species at low population densities, e. g., American shad, hickory shad, striped bass, and yellow perch or those fish with a limited distribution within the state, e. g., longnose gar, shorthead redhorse, mottled sculpin (Butler Mill Branch above Craig's Pond only), and shield darter (one location only).

VI. NEEDS OF THE HUMAN POPULATION USING THE AREA

A. Employment

The Sussex County Office of Economic Development provides the following list of major employers in Sussex County.

Major Employers and Location

E. I. DuPont De Nemour's, Inc. Seaford (Nylon Production)
Perdue, Inc. Georgetown (Poultry Processing)
Townsend's, Inc. Millsboro (Poultry Processing)
Draper King Cole, Inc. Milton (Food Processing)
Nanticoke Homes, Inc. Greenwood (Manufactured Homes)
Indian River School District Dagsboro (Education)
Allen's Hatchery, Inc. Seaford (Agricultural Production)
Nanticoke Memorial Hospital Seaford (Hospital)
C.C. Oliphant & Son Laurel (Roofing Construction)
W. B. Venables & Sons Laurel (Construction)

B. Social Strata and Economic Status.

The nearest towns to the Wildlife Area are Bethel and Laurel. Bethel is a small bedroom community with a slightly declining population of 180 people. The median per capita income level for Bethel is higher than the average for the County ($10,432 versus $9391 - 1985 estimate). The town has a designated historical district and was once a sailing ship- building town.

Laurel is a much larger town with one of the most rapidly growing populations (3710 - 21.5% growth from 1980) of any inland (non-resort) town. It also has a historical district centered on the town's past prominence as a center for the distribution of farmed goods and shipbuilding. The average income is $7,002, $2,000 below the County average income and the second lowest of any other Sussex County town. Laurel is a town of contrasts - one of historic old homes and substandard housing that comes with poverty and unemployment. Laurel's current drug and crime problems receive lots of media attention.

Median income for Sussex County families is the lowest in the state ($16,909) and 13.6 % of the population is living below the poverty level. There is no significant difference in the poverty level between the rural and urban populace in the county. Wages in the area surrounding the Wildlife Area are considerably lower than the county average (Sussex County Office of Economic Development 1986). The median home value in Sussex County was $38,3000 in 1980. Housing off the water in the majority of Little Creek and Broad Creek Hundreds is less than the County average housing prices.

As previously mentioned, the Nanticoke Wildlife Area has several existing and proposed housing developments within a few miles. The income levels and social strata of the residents are somewhat higher than closer to Laurel, but not significantly greater. Most of the farms surrounding the Area are farmed for corn, soybean, or watermelon along with broiler production.

The chicken growing and processing industry generates $340 million dollars of broiler chickens each year. Many people grow chickens as a second source of income. The three major cash crops are soybeans, corn, and vegetables and melons which produce $ 40, $38, and $31 million dollars of product each year, respectively. Western Sussex County around Laurel is especially known for its watermelons. Forest products generate $2 million each year (5 % of the total soybean economic yield). Jobs related to housing for the resort towns, big industry, e.g. Dupont Seaford Plant, and retirement are important to the local economy.(Sussex County Office of Economic Development 1986).

C. Population Growth.

Sussex County has the highest projected growth rate in the state. Sussex County is expected to grow at a 5.9% rate compared to 3.07% in New Castle and 2.3% in Kent County. Most of that growth will occur along the coast and Inland Bays, however Laurel is expected to grow by 21 % in the next 5 years. Excessively high land prices on the Inland Bays have sparked more interest in waterfront property in western Sussex where prices are relatively low (Sussex County Office of Economic Development 1986).

D. Users.

Results of the hunter mail survey indicate that Nanticoke Wildlife Area receives the second least amount of hunter use of any other Wildlife Area in the State (Whittendale 1986) . I feel this is a deceiving statistic which should be interpreted with caution. A majority of the survey respondents live in New Castle in the major towns in Kent and New Castle Counties. Nanticoke's relative isolation precludes use by hunters from the northern end of the state. However, many who live in Sussex County and Maryland use the Area regularly.

Summer use is heavy. The area is used most for fishing, picnicking, swimming, horseback riding, and pleasure rides in automobiles. No data on total number of non-hunting users, their place of residency, or their principal activities are available.

E. Interests, customs, and prejudices of groups.

Deer and small game hunting attract most of the hunting interest at Nanticoke. The deer firearms (shotgun and muzzleloader) seasons receive most of the participation, particularly during the early and the more recently introduced (1989-90) January shotgun season. Archery and blackpowder deer hunters are a distant second and third user group. Small game hunting is popular with species hunted in this order of decreasing participation - squirrel, bobwhite quail, cottontail, and mourning dove hunting. As more management efforts are put into the dove fields, use has increased, but is limited to the early season.

A stable and corrals are located directly across Phillip's Landing Road from the Wildlife Area. The local horse riding club uses the Area frequently.

Firearms owners or "plinkers" use various places on the Area for target shooting, although no designated shooting area exists. At one time the old dirt pit was designated as a shooting range, but interest waned and trash started to pile up, and the area was closed off in 1986 to vehicles. Since that time most of the shooting occurs at the gate sites.

Many people believe that the wildlife area is a state park because the fishing area (Phillip's Landing Recreation Area) is equipped for boating, fishing, and picnicking. Several adults have told me that the George Adam's Field was the place to "party" when they were growing up. That practice has been discouraged and a gate erected to keep vehicles out of the food plots. Trashing associated with "partying and parking" continue to be a management problem.

The Delmarva Ornithological Society conducts a Christmas Bird Count here each year. The Breeding Bird Survey conducted and coordinated through the U. S. Fish and Wildlife Service has a volunteer participant who runs a route through the Area.

Phillip's Landing provides one of two boating access points to the upper Nanticoke River and tributaries. Numerous fishing clubs practice for and participate in bass fishing tournaments throughout the spring, summer, and fall months. Permits for these events are issued by the Fisheries Section of the Division.

F. Management directives based on user needs and desires.

1. More deer stands should be erected and provided on a first-come, first-served basis to hunters without private land to hunt.

2. More information on the nontraditional users needs to be collected. A weekend survey done during the spring, summer, and fall months would give us a better idea of who these people are, how many there are, where they travel from, what brings them here, and what they need.

3. Educational signs placed along the main roads will reach the "drive-through" public. Signs explaining food and cover plot management, general management objectives, and area history would be most appropriate.

4. Birdwatchers, photographers, and nature lovers should be given greater access to the wildlife resources in ways compatible with wildlife protection.

5. More emphasis should be placed on informing the public of best use of nontoxic shotgun ammunition.

6. A shooting range facility should be erected in a central location in Sussex County which provides an alternative to illegal target shooting. Designating a shooting area on the wildlife area without proper supervision and equipment may satisfy some local needs, but invites more vandalism and liability problems.

VII. COORDINATION MEASURES AND BROAD MANAGEMENT OBJECTIVES.

The Division's goal is perpetuating the natural diversity of indigenous plant and animal communities and restoring extirpated species when possible. We will encourage, manage, and support the wise use of our wildlife resources as long as their viability is not jeopardized. Our approach will be to manage ecosystems, to maximize plant and animal diversity and thus increase ecosystem stability.

Our first responsibility is to the wildlife and their habitat. A species' viability must be secure before we fulfill our second responsibility - to manage our wildlife resources for recreation, economics, and scientific instruction. We are committed to the concept of multiple-use management provided the practice does not harm the resource or infringe upon the rights of others. Balancing user's needs while conserving the resource requires careful planning and the application of prudent management policies.

1. We are committed to managing ecosystems. We will recommend no action that threatens the viability of a native species or population.

2. We will manage wildlife species as viable, self-supporting, and free-ranging populations. Consideration will be given to all species to maintain diversity and stability and to maximize the variety of human experience.

3. Restoring native species which have become extirpated will be one of our goals provided that their reintroduction does not adversely affect man.

4. We will acquire land for wildlife habitat management purposes when that land is a manageable size, adjoins our property but doesn't create inholdings, or provides habitat critical for a threatened species.

5. We will consider consumptive and nonconsumptive uses and oppose competitive use that are detrimental to wildlife populations or habitats.

6. Population and habitat manipulations are acceptable management tools provided the viability of a species is not threatened.

7. We recognize hunting, fishing, and trapping as legitimate management tools and as recreational pursuits. We will strive to meet the demands for hunting and trapping as long as species viability is not jeopardized.

8. We recognize that some competitive land uses are essential to human well-being; we will mitigate on uses beyond our control and educate competitive users of the trade-offs.

9. Fulfilling our goals requires public support. We will attempt to educate people to wildlife benefits and instill a sense of responsibility towards the resource.

Timber harvest will be used as a habitat manipulation tool and as a revenue source. Small timber sales (less than 15 acres) provide early successional stages of vegetation, promote herbaceous growth, create escape and nesting cover, and increase interspersion. Timber harvests will be planned with the premise that wildlife management objectives have priority over strict income generation.

Wildlife management is balancing the needs of both animals and people. The same principle applies on the wildlife areas. Recreation is permitted provided it does not interfere with some critical segment of an animal's life cycle. Nor will one person's recreational endeavors disrupt, interfere, or diminish the enjoyment of another's recreation. Off road vehicles are incompatible with the objectives of this wildlife area and will not be permitted. The wildlife food and cover plots are off limits to unauthorized vehicles, and horseback riding. These areas provide undisturbed nesting areas where human interference is minimized. The Phillip's Landing Recreation Area is adjacent to several wildlife food and cover plots. Picnicking
is restricted to the fishing areas. The wildlife area and interior roads will be open for legitimate wildlife management work, animal surveys, educational tours, and other nature appreciative activities.

VIII. WILDLIFE MANAGEMENT PRACTICES

A. Statement of Priority of Practices.

The Robert L. Graham Nanticoke Wildlife Area is primarily managed for white-tailed deer, northern bobwhites, eastern cottontails, gray squirrels and mourning dove. Waterfowl have secondary management priority, however this area will be a small part of the Blackwater-Nanticoke Focus Area of the Atlantic Coast Joint Venture (North American Waterfowl Management Plan). Increasing emphasis will be placed on the recognition and protection of amphibians and reptiles. Rare plants and freshwater wetlands will be given special consideration.

Several box huckleberry sites have been identified on the wildlife area by the Natural Heritage Program. One tract of land - the Good Property was bought by Delaware Wildlands, Inc. to protect the site, then re-sold to the Division. These areas will be given a high priority in keeping with the Division's explicit policy of protecting species viability and ecosystem diversity and stability.

Archaeological sites will be protected and perpetuated as they are identified on the wildlife area. Every reasonable precaution will be taken to eliminate or minimize disturbance to prehistoric sites during construction activities. Normal management practices would not be expected to disrupt any sites of archaeological significance due to their limited nature. Before potentially damaging activities are begun the Staff Archaeologist with the Division of Parks and Recreation will be consulted.

B. General Habitat Management Techniques

1. Wildlife Food and Cover Plots

Although wildlife populations increase or decrease in response to management practices that affect vegetational succession, food plots have long been the "public's answer" to optimum wildlife habitat (Clark 1980). Although food plots are not a panacea to wildlife woes they do provide abundant, nutritional food during the "pinch" period, keep some areas in an annual stage of succession and increase wildlife viewing and hunting opportunities. The plots are utilized by several game and nongame species.

The food plots are generally planted with a mixture of grains - soybean, Japanese or German Millet, sorghum, buckwheat, and sunflowers (Appendix 3). Pure stands of sunflower and corn are planted in the managed dove hunting fields and as a late winter food and cover crop.

Wildlife food plots are planted in grains and grasses to provide both food and cover. Although the plots are referred to as food plots, they should be thought of as food and cover plots.

The wildlife food and cover plots will be planted near brushy cover when possible. The seed types planted for bobwhites specifically are soybeans, millets, lespedezas, oats, and wheat. A

balance of domestic and wild seeds will be provided in the plots. No effort to control "weeds" will be made in order to provide both food and cover upon the plots. Plots greater than an acre will be divided in half and put on a two year rotation. Fields smaller than one acre will not be divided, but will have grassy edge. Disked strips in the fallow half will encourage native annuals and expose bare soil for nesting and dusting. Each food plot will have a minimum of 25 feet of grass edge which will be mowed, disked or burned every 3-4 years.

The following grasses are recommended for the edges of the wildlife food and cover plots : alfalfa, orchardgrass, clover (Trilobium spp.), reed canarygrass (Phalaris arundinacea), Korean lespedeza (Lespedeza stipulacea), and switchgrass (Panicum virgatum). The seeding rate should be heavy enough to establish the stand, but light enough to create 50 % bare ground. Grasses which clump are best, e.g., switchgrass.

A record of the species planted in the wildlife food and cover plots from 1985 until present, and acreages is listed in Appendix 7.

The soil fertility will be maintained using inorganic fertilizers according to soil test recommendations and long rotations. Leaving the crops unharvested leaves most of the nutrients on-site and in the ground, therefore soils will be tested every five years. Pesticide and herbicide use will be restricted to those demonstrated to be safe around wildlife. Applications will be performed in accordance to the label instructions. Their use will only be considered when no other alternative is feasible.

2. Disking

Annual and perennial native vegetation are very important components of habitat. Annuals and perennials must be maintained in various stages of succession to be of optimum value and use to wildlife. Disking is one way to encourage annual plants to volunteer along with perennials. Seeds laying dormant deep in the ground are brought to the surface and allowed to germinate.

Disking stands of sod-forming grasses allows other annuals to grow and restores diversity of food and cover. Disking may be required at 3-4 year intervals. Strips should be disked in the idle parts of the food plots because it creates edge and encourages nesting. Disking should be done from September 15- March 31 (in areas not planted) to avoid disrupting nesting. Disked strips will be a minimum of 15 feet width.

3. Prescribed Burning

Prescribed burning is one of the most economical procedures for manipulating wildlife habitat. Burning is used to reduce plant competition, prepare seed beds, stimulate regeneration of sprouts and seedlings, and create openings in dense stands. Low intensity fires increase both the quality and quantity of forage plans, seed-bearing plants, and insects (Schemnitz 1980).

Small fires that do not burn fast enough to trap wildlife will be used. Burning on Nanticoke should be done between February 20 - March 31. Burning between these dates will make some seed for wildlife available during this time of food shortage, but take advantage of the soil moisture and temperatures common in the late winter. The following authorities will be notified before

burning - the Capitol Communication Room (739-4580), the Fire Control Board (856-6306 non-emergencies), and the Wildlife Section Office (739-5297) in Dover. When appropriate owners of lands bordering the burn will be notified.

4. Hedgerows

Hedgerows can break large fields into smaller ones creating greater edge and escape cover near a food source. Hedges are living fences and serve as a physical and visual barriers. Wildlife use increases with less disturbance. Evergreens provide overhead cover during cold weather and give animals a place to escape avian predators and freezing rain or snow. Tree and shrub species that provide both cover and winter food are: Autumn olive (Elaeagnus augustifolia), amur honeysuckle (Lonicera maacki), barberry (Berberis spp.), silky dogwood (Cornus amomum), sumac, Japanese multiflora rose (Rosa multiflora), grape vines (Vitus spp.), VA-70 shrub lespedeza (Lespedeza bicolor), and bayberry. Trees which provide some food and could be planted in hedges (or favored during a timber harvest) are: black locust, American beech (Fagus grandifolia), sweetgum, pines (Pinus spp.), mulberry (Morus spp.), sassafras, and oaks (Quercus spp.).

Both multiflora rose and autumn olive will spread when passed by animals. This species are used on wildlife areas where continuous cultivation keeps them in check. Neither are planted in areas where their intrusion will cause a problem for equipment or vehicles.

5. Mowing

Mowing sets back succession and stimulates new plant growth. The openings created provide travel lanes and sunning sites as well as shooting/viewing lanes for hunters/wildlife watchers. Strips mowed through brush create more edge by providing openings for sunning, dusting, and feeding. Mowing will be done before or after the nesting season. If an area must be mowed for safety, aesthetics, or brush suppression, a predetermined lane can be mowed regularly and will discourage animals from nesting in the short grass and reduce losses to the mower.

C. Outline of Species Management Plans.

1. Habitat needs in relation to life cycles.
    - A. Feeding Cover.
    - B. Nesting Cover.
    - C. Escape Cover.
    - D. Resting Cover.

2. Methods of providing types of cover.
    - A. General techniques such as mowing, disking, burning, or hedgerows.
    - B. Plantings for food and cover-maps, plantings, cost.
    - C. Annual schedule of practices.

3. Evaluation of habitat management practices.
4. Specific recommendations for each species.

5. Hunting or trapping program.
    A. Population status - survey methods and results.
    B. Trends in human demand for resource.
    C. Plans to match supply of resource with demand.
    D. Description of permit system.

D. White-tailed Deer

1. Habitat Needs

Nutrient requirements of deer vary with age class, reproduction cycle, and weather. Young deer require high levels of protein, phosphorus, and calcium. The deer's diet depends primarily on what food is seasonally available. Daily movements of adults are associated closely with feeding routines. Deer feed most actively early in the morning and during the evening. Deer may travel several kilometers within their home range in their daily search for food. In Delaware where the winters are mild, deer remain on their home ranges year-round. The greater the variety of plants, the greater the chances are of achieving full productive potential.

Browse (leaves, stems, and buds of woody plants) is the mainstay of a deer's diet, mainly because of its year-round availability (Halls 1973). Many plants species are eaten, but browse is utilized most in the late fall and winter. Browse consumption is highest when acorns are scarce (Harlow et al. 1975). The quality of browse is highest in the spring and lowest in the winter - when the older hardwood twigs are usually eaten.

Forbs are eaten heavily in the spring when they are green and succulent. When available in quantity, forbs such as legumes, constitute better than 50 % of the diet and account for 25 % of the protein. Native grasses are not important in the deer's diet
(Halls 1978).

Deer prefer certain species of plants. Succulent plants are more palatable than dry plants. The more nutritious plants are usually the preferred ones. Leaves are more palatable than twigs, and twig tips more so than old growth twigs. Evergreen plants are preferred to deciduous plants during the winter. Soybeans and winter pastures of annual grasses and legumes are eaten readily when available close to forest habitats (Halls 1978). Deer drink water when available but can go for a long time without it. Deer will use saltlicks and saltblocks in the spring, but do not appear to need sodium the rest of the year (Halls 1973).

In the North and West, cover is a critical factor in providing adequate protection form extreme winter weather. In the South, there is seldom a lack of adequate cover for deer, except in large tracts of clear-cut forests or where brush is cleared in favor of grasses (Halls 1978). An interspersion of hardwood and evergreen tree cover is most likely to meet the year-round needs of deer. Hardwoods contribute fruit and browse, while evergreens provide cover.

Acorns are a major protein source. A balanced mixture of trees representing the black and white oak groups provides an ideal acorn supply for deer. Black oak acorns mature every two years, while white oaks produce acorns each year. Nanticoke has three dominant oaks - White, Southern

Red, and Willow. White Oak is the only tree to produce acorns every year. Willow Oak are also favored browse species.

2. Habitat Management Recommendations

To produce acorns, the oaks should be at least 8-10 inches in diameter, have fully developed crowns, and maintain a dominant or codominant position in the canopy. Acorn yields are favored by long rotations and periodic thinning. In the South, good deer habitat should contain 19 oaks per acre. Other hardwoods such as dogwood (Cornus floridanus), cherry, and blackgum contribute fruits readily eaten by deer (U.S. Forest Service 1971).

Timber cutting units should be distributed into a pattern of many different aged stands. For an 80 year rotation in the South, 20 % of the even-aged stands should be less than 15 years old, 30 % aged 16-49 years old, and the rest older (U.S. Forest Service 1971).

A Forestry Plan for Nanticoke and prepared by the State Forest Service will become a part of this management plan. It is recommended that a diversity of stands with different age classes be distributed in the area. Timber harvests will be less than five acres and cut in small rectangular or irregular shaped clear-cuts. To maximize browse yield while establishing a diverse age class, small clear-cuts will be done every five years until a 80 year rotation of five age classes is established.

Periodic thinnings will be used to encourage acorn production in the larger trees and to stimulate browse production. Browse will primarily come from stump sprouts within the harvested areas. Thinnings will be performed using a U.S. Forest Service recommendation of leaving a residual tree basal area of 70-78 square feet per acre for southern pine-hardwood stands. The effects of timber-cutting on forage production are temporary. Herbaceous plants resprout quickly, but yields peak in 1-2 years. Browse yield peaks in 3-5 years after a thinning. Yields declines as crowns close and trees grow out of the deer's reach (Halls 1973).

The first year after a fire, crude protein and phosphorus content of forage increases. Burning increases the palatability of food by stimulating stump sprouts and favors herbaceous growth by removing the leaf litter. Halls (1978) recommends that southern pine forests be burned every 3-5 years for forage production. Burning to increase forage availability will be done in conjunction with renovating pastures and switchgrass or seedbed preparation after a timber sale. However the need for burning Nanticoke's mixed forest to stimulate deer forage seems minimal.

Openings within the forest add to the variety of food and cover, provide consistent and abundant sources of food, and increase edge. Openings should comprise 2 % of the total forest area (Halls 1978) and be well distributed in the stand.

The existing food and cover plots serve as openings. The grassy edges will be replanted in clover every 3-5 years. Three fields along an interior road (Fields 11-13) are presently planted in food plots. They will be planted in 1990/91 to pasture for deer, turkey, as "bugging" areas for turkey and quail chicks, and as feeding and nesting cover for cottontails. A pasture planted in a clover/grass mixture in the fall of 1989 was browsed heavily by deer. The same mixture will be used along the edges of the current food and cover plots. The pastures will be fertilized with a 0-12-

12 granular fertilizer and mowed regularly to exclude woody growth and keep the foliage succulent.

Soybeans are already planted in a mix on the food and cover plots. The beans are highly palatable and high in protein. Other crops are used by deer as well.

Deer sign was heavy in the milo sorghum in 1989 when we had a good crop. The deer were eating the seed heads. Milo will continue to be planted in the mixture for seed-eating songbirds, bobwhite, and deer. Deer were seen feeding in winter wheat. As the wheat has proven a good goose and dove food, its attractiveness to deer makes wheat a better candidate for the future.

3. Deer Hunting Program

The deer herd on the Nanticoke Wildlife Area appears to be stable or slightly expanding. On a statewide basis, the deer harvest has been increasing (Reynolds 1990). There is no reason to suspect that the habitat on Nanticoke is inferior to habitat on a county or state wide basis. Based on the similarity of habitat, it appears that the herd on the Area is following the same trend. Long term records specific to the area are lacking however.

The deer management program will be evaluated by examining the harvest records and correlating antler beam diameters from yearling bucks taken at Nanticoke with bucks killed statewide. Harvest data will be examined to look at body weights of fawns taken on the area. The capacity of the deer herd to expand is governed by the number of fawns which survive the first winter. Evaluations of the quality and quantity available to the fawns should help predict their survivability and the herds chance of expanding. Food plot utilization will be examined using the food plot survey and possibly a night spotlight count.

Reports on deer damage to crops in various parts of the state prompted the legislature to grant the Division the authority to issue antlerless deer permits to landowners in certain portions of the state or who could demonstrate deer damage outside those areas. The area surrounding Nanticoke was included in the first Bonus Deer Program (November 1990). To my knowledge no neighboring farms have experienced severe deer-related crop damage. No permits were issued on Nanticoke.

Beginning in 1985 hunters checking deer at each state check station were asked if the deer was harvested on public land. Data collection was spotty because of checking station personnel's unfamiliarity with the procedure. In 1987 a form was used to tally the number of deer killed on public lands. This survey recorded one deer harvested from Nanticoke. An analysis of the deer killed in sampling grids (13.5 square mile blocks) surrounding the Wildlife Area indicated that 51 deer were taken within a three mile radius of the Area Headquarters. Additional data collected by extrapolating kill from grid numbers or from sampling hunters at the State Checking Stations are presented in Table 4.

Table 4. Distribution of deer harvested at (or near) Nanticoke Wildlife Area during the November shotgun season 1985 - 1989. (from Ken Reynolds, pers. comm. 1990).

1985	1986	1987	1988	1989

Block #

1016	13	12	13	15	16
1017	2	5	5	-	-
995	2	8	8	-	-
994	29	28	24	-	-
1039	0	0	1	-	-
	45	53	51	15	16

Locations of Block #
1016 - near Phillips Landing on Henry Tract.
1017 - east of 1016 towards Portsville Pond.
995 - along Nanticoke River on Red House.
994 - northwest of Red House Tract.
1039 - near the Prickley Pear Island.

Most deer harvested from 1985-87 were killed off the wildlife area in the Woodland Ferry Road area. The numbers are not an estimate of harvest on Nanticoke, but give us a feel for the potential for harvest and probably the degree of hunting pressure in the area northwest of Red House. Data for 1988-89 was taken without any reference to a block number. The hunter checking a deer at a state deer checking station was asked if the deer was killed on private or public lands. If the answer was "on public land", than they were asked on which State Wildlife Area, Forest, or Park? Ken feels that the 1988 & 1989 harvest estimates were low because not all hunters were asked the question, but the numbers indicate a fairly stable trend.

The demand for public deer stands increases each year. Ten deer stands were installed in 1989 centered around the larger fields. Use of the deer stands was authorized on a strict first-come, first-served basis. Ten more stands were added in 1990 to provide additional recreational opportunities to public lands hunters. No stands are presently on the Red House Tract. Based on the amount of trash and vandalism occurring on Red House, I feel any new stands will be placed where they can be protected by a locked gate. More stands are needed, but will be added gradually as demand rises.

Deer stands are maintained by area personnel, but built at the Little Creek shop by inmates from the Morris Correctional Center in Dover. The stands are made of 12 or 14 foot four by fours, and stand nine or eleven feet off the ground. The steps, seat, and handrails are the most frequently repaired components. Before each season the paths to the stands are cleared of obstacles. The steps and platform are checked. The results of the inspection are recorded on a Deer Stand Repair Checklist (Appendix 5).

4. Hunting Program Recommendations

a. More deer stands are needed to increase the harvest and accommodate anticipated increased demand. Until 1989, no stands were available to hunters. Ten stands were erected in 1989 and ten more were installed by 1990.

GOAL - 40 deer stands.

b. Change the hunting regulations to allow archery deer hunters to use self climbing stands provided they hunt within 120 feet (40 yards) of the stand they are assigned. This change will improve the hunt and still allow us to maintain safety standards.

c. Establishing an state check station in the southwest section of the state, possibly at Nanticoke headquarters, will improve reporting rates for the Wildlife Area and county wide.

d. Until a local checking station is established, the effort to cross-check deer killed at Nanticoke and checked in Georgetown and Bridgeville checking stations should be continued.

E. Northern bobwhite

1. Habitat Needs

Northern bobwhites are the most popular and abundant non-migratory game bird in Delaware (40,000 harvested in 1985) (Whittendale 1986). Their abundance in Delaware is strongly related to the availability of their preferred habitat - old fields overgrown with shrubs adjacent to a field of annual grains and an open woodlot (U.S.D.A. et al. 1972).

Bobwhites nest in open, grassy areas with 50 % bare ground. An example of an ideal nest site could be an area that was burned one year ago and is located near a grassy area with exposed mineral soil nearby. Seventy-five percent of all nests are located within 50 feet of a field edge adjoining woods, brush, or hedgerows.

A preference for intermediate successional stages exposes the bobwhite to frequent contact with human disturbances such as mowing, plowing, disking, and planting crops. Egg and chick mortality is high but offset but large clutches and the ability to renest. A bobwhite is a prolific breeder (12-15 eggs per clutch), a resilient re-nester (60-70 % of first nests fail) and a seed eater with an eclectic palate. All of these are ingredients for survival alongside man.

Bobwhites are mobile, but home ranges are small. A covey can cover a 1/4 to 1/2 mile a day, but usually range less than 1/4 mile. Good habitat can go unused when not distributed so the birds can find it. Food, cover, and water must be present with this small home range for optimal utilization.

Bobwhites are seed and greens eaters. Some insects are eaten by adults, but young birds must have an adequate supply of insects for protein for tissue development. Food habits studies in this area show soybeans, lespedezas (Lespedeza spp.), corn (Zea mays), jewelweed (Impatiens pallida), sweetgum, black locust (Robinia pseudoacacia), poison ivy, and honeysuckle (Lonicera japonica) to be the most commonly utilized foods . Partridge peas (Cassia fasciculata), ragweed (Ambrosia spp.), beggar-tickweeds (Bidens spp.), oats (Avena spp.), sumac (Rhus spp.), crabgrass (Digitaria spp.), smartweed (Polygonum spp.), millet (Echinochloa spp.), barnyardgrass , and

foxtail (Alopecurus spp.) are also heavily utilized (U.S.D.A. et al. 1972). Food supplies are usually adequate, except when ice or snow cover them or the seeds are too far from protective cover. Seed sources should be within 75-100 feet of good escape cover.

2. Habitat Management Recommendations

All the needs of a covey can be provided in a managed 15 acre unit. Each covey needs 1) at least one 600 square foot block of dense cover. 2) one acre (2 acres on infertile soils) of annual food plants, weeds, and/or grains within 100 feet of cover, 3) one quarter of an acre of grassland within 50 feet of cover for undisturbed nesting and 4) one eighth acre of food bearing shrubs (U.S.D.A. et al. 1972).

The following recommendations will be incorporated in manipulating quail habitat:

a. No mowing or tilling within 50 feet of field edges during late May, June, and early July to avoid disrupting nesting.

b. Field edges with more than 50 % ground cover will be burned or disked in February, March, April, or early May.

c. Roadsides will not be sprayed or mowed unless deemed necessary for safety or public access. Any mowed areas will be kept short to discourage nesting attempts and prevent killing young rabbits.

d. Prescribed burns of food plots, fields, or woods will be done between February 15 - March 20 (dates flexible depending on the weather).

e. Crops will be left standing except in dove fields. Mowed strips beside crops will be maintained throughout the growing season to create shooting lanes and allow dog training access.

f. Mowing to eliminate unwanted woody growth should be done in midsummer only (August 30 - September 30). If possible an unmowed area should be left adjacent to mowed area for escape and cover.

g. Strips at least 15 feet wide should be disked in the fallow food plots to encourage annual food plants and improve nesting cover. Strips should be disked before burning grass edges to protect nesting cover.

h. Grass edges will be burned every three years or when less than 50 % bare ground shows.

i. A minimum of 25 feet wide grass edge will be left on either side of a hedge unless the hedge borders a woods-then only one side needs grass.

j. The woodlands will be managed as small even aged stands managed on long rotations to provide a continuum of age classes. Saw log production will be half of optimum to maintain a 60 % crown closure. Loblolly pine will be managed on 50 year rotations.

k. Prescribed burns will be an integral part of woodland management.

GOAL: 10 COVEYS - HENRY/HASTINGS TRACT.

GOAL DETERMINATION BACKGROUND:

PLUSES: 55 acres of wildlife food and cover plots on 23 sites provide food in proximity to escape cover, 16 miles of interior access road to serve as edge, and the woods provide good crops of mast.

NEGATIVES: large acreages of woods with open understories, a low field to wood edge ratio, 22 acres of the 55 in three fields, lack of nesting cover and winter escape cover. The REDHOUSE Tract has no openings or appropriate habitat.

F. Eastern Cottontail

1. Habitat Needs

Rabbits have very small home ranges (less than five acres) and spend most of their lives within 150 feet of dense brushy cover. Rabbits need grass for nesting cover; grasses and legumes for food; and dense brush and vines for escape and winter food.

2. Habitat Management Recommendations

The management of food and cover plots and surrounding habitat will include some or all of the following idealized management approaches (from Delaware Wildlife Management Guide).

In a five acre area, the following habitat types should be developed:

a. Four or five small (1/10 to 1/4 acre) plots of grass near brush cover for nesting. Area should not be cultivated or mowed during the summer.

b. Three 15-20 foot by 50 feet strips of grass/clover for feeding. Strips should be fertilized annually and mowed in May and July to keep the grasses succulent. The strips should be mowed one half at a time to leave some cover and avoid mowing rabbits.

c. Two acres of tall perennial weeds between the grass nesting and feeding strips. Mow, burn, and disk small portions each year until the whole two acres is treated every three years.

d. Leave three brushy strips ten feet wide by 100 feet long for summer feeding cover and winter food. Hedges will serve this purpose well.

e. Four or five small (1/10 to 1/4 acre) patches of heavy dense brush, briars, and vines for escape cover and food. Dense patches of conifers with low-growing branches will provide this type of cover. Blackberry (Rubus sp.), greenbriar (Smilax sp.), and Japanese honeysuckle (Lonicera japonica), can be dense enough to provide escape cover.

Rabbit management is more labor intensive than deer or quail management due to the summer mowing. However when grassy edges are planted and maintained along the food and cover plots, rabbit habitat needs are met.

Annual fertilizing on the cultivated food plots is done with a truck and the grassy edges will be fertilized with the same mixture. Mowing feeding cover and protecting quail nesting cover would seem to be in conflict. If lanes are mowed through the grass plots in the early spring and maintained by weekly mowing, nesting is discouraged and feeding cover optimized.

The addition of hedgerows will provide escape and resting cover for rabbits to the food plots. Each hedge has a deciduous and an evergreen species to provide food and winter cover. Another management practice which will benefit rabbits is fallowing half of the plot each year. The fallow portion will provide an undisturbed area for feeding and nesting. Field border widths were increased in 1990. A minimum of 25 feet of brush and tall perennial plants will be left along all hedges and field edges. Blackberry patches will be left undisturbed. When the natural vegetative cover is not present, brush piles measuring 15 feet in diameter and 5 feet height will be built along the interior of woods near food and nest cover.

GOAL: MAINTAIN A HUNTABLE POPULATION ON A SUSTAINED YIELD BASIS.

BACKGROUND: No literature available with comparable habitat to determine reasonable density goals. Capture-recapture estimates very labor intensive and not always reliable.

G. Gray Squirrel

1. Habitat Needs

Although squirrels eat wide variety of foods (mushrooms, insects, berries, grasses and buds), it is essential that they have a source of mast to carry them through the winter. Oak trees are the most important producers of mast (acorns and other nuts), but hickory (Carya spp.), beech, and walnut (Juglans spp.) are also important.

Squirrels must have den trees to reach maximum populations levels. Dens provide protection from predators and weather. Although they are essential for squirrels, den trees have no value in timber management. The best den trees are usually white oak, maple, beech, and red oak. Den trees that provide food and have a durable heartwood are best, e.g., white and red oaks, black walnut (Juglans nigra , chestnut oak (Q. prinus), blackgum and red maple(Acer rubrum).

Squirrels have two litters when mast is plentiful - one in March and another in late June or early July. Litter sizes range from 1 - 6 with an average of 2 - 4 (Madson 1964). Breeding occurs in January with birthing occurring six weeks later, usually in early March.

The gray squirrel is found where shrub and ground layers are very thick (50-90 % shrub layer closure and more than one stem per square foot). Nanticoke has an abundance of this habitat.

2. Habitat Management Recommendations

a. Survey areas for den tree densities and determine if natural den sites are limiting. Den trees should be 15 inches in diameter or larger. Cavities 20 feet high or higher with a 4 inch entrance, and between one and 3 feet deep are ideal. This combination of size and depth is an ideal balance of protection from predators and severe weather. Three den trees per acre are recommended.

b. Install more nest boxes in areas with less than 3 den trees per acre. When less than three natural den trees per acre are available, den boxes may be desirable. Den boxes 17 inches wide and 18 inches high placed over 20 feet high in a mast-producing tree and attached above a usable limb is best. The entrance should face away from the prevailing winds. No bedding or vent holes are needed. Den boxes should be placed away from natural dens. Check and clean out the boxes in March and July each year.

c. Continue to check the nest boxes in March and late June/early July. Clean out and repair boxes when necessary. If non-target species are found using the boxes, they will be left undisturbed and another box placed nearby.

d. Create a favorable balance of mast-producing trees when replanting future timber harvest sites. It is recommended that the following mast trees be left per acre: 5-10 hickories, 5-10 beeches, and 10-15 oaks. Overall, at least 15 square feet of basal area per acre of mixed, all-age timber be left for optimal squirrel habitat. Also shrubs and smaller tree species such as hazelnut (Hamamelis), dogwood, and black cherry should be left (U.S.D.A. et al 1972).

e. Identify and save den trees (3 trees per acre) prior to any future timber sale.

GOAL: MAINTAIN A HUNTABLE POPULATION ON A SUSTAINED YIELD BASIS.

BACKGROUND: The species dependence on mast crops strongly influences the yearly population fluctuations, however nest site availability is a limiting factor which can be controlled. Nest boxes should improve the habitat in marginal sites and help dampen the population swings.

H. Mourning Dove

1. Habitat Needs

Mourning doves are common throughout Delaware and on Nanticoke Wildlife Area. The breeding season begins in March and extends to September with peak activity from mid-May to mid-June. A flimsy nest of grass and twigs usually built in a conifer with dense branches or a suitable tree branch crotch requires a broad surface to balance the loosely assembled materials. Conifers 10 - 30 feet tall provide excellent nesting and roosting cover. A pair of doves may average three successful broods from 5 or 6 nesting attempts and produce 5 young per season (U. S. D. A. et al 1972). Eggs hatch in only 15 days. Adults can renest every 33 days.

Mourning doves are found primarily in agricultural areas near conifer stands. Hedgerows are also used for nesting if enough evergreen cover and an ample seed supply is nearby. Wood margins, woodlots, and residential areas with plenty of trees are also used for nesting and rearing sites.

Young birds feed on "milk" produced in the parents' crops, but once fledged, seeds become the staple. Doves glean seeds from ground with short or sparse cover. Almost any type of seed is eaten ranging in size from a tiny barnyard grass seed to wheat, corn, and sunflowers. Waste grains form the bulk of their fall and winter diets. Corn and wheat account for up to 50 % of the diet in Delaware (U. S. D. A. et al 1972). Greens and insects form a minor portion of the diet.

Mourning doves are common throughout Delaware. Largest numbers occur between September 15 and October 15 when locally produced birds are joined by migrants moving though from further north. Peak of the spring migration in Delaware is between March 10 and April 10 (U. S. D. A. et al 1972).

2. Habitat Management Recommendations

Management efforts for mourning doves are usually directed towards providing nesting and feeding habitat. The dove's poorly constructed nest of twigs and grass can be enhanced if built in a wire cone nesting structure. Cone nest supports can be constructed by cutting a twelve inch circle of 1/4 or 3/8 inch mesh hardware cloth, then removing a pie shaped wedge from one side with tin snips. The edges of the cut wire are pulled across the opening to close it forming a cone. Two nails on each side of the nest will hold the cone in the crotch of a tree. Dry grass can be placed in the nest for nesting material and to increase the nest's visibility. Where nesting cover is lacking or where predators such as cats are abundant, nest cones receive good use. The nest support should be placed 6 - 16 feet above the ground in moderate shade. The surrounding limbs should be open to allow easy flight escape.

The mourning dove's diet of seeds makes management for hunting purposes easy. Fields planted in annual grains are planted to provide mature seed near the opening of the dove season which has traditionally been September 1st. The plants are mowed, disked, or harvested so as to provide excess seed on bare ground. Sunflower, buckwheat, millet, winter wheat, barley, and oats are popular plants for planting and mowing before the season opens. Corn and soybeans which are lost in harvesting provide ample food to doves later in the fall and winter. After harvest discarded melons are disked to attract doves. Corn fields can be over-seeded with Japanese millet during the last cultivation. Proso Millet is used the same way prior to cutting silage. An area near the seed source is generally disked to provide easy access and girt for the birds. Dove strips need not be

large - a 10 X 50 foot strip is acceptable. Large dead trees near the dove shooting area seem to attract birds who survey the area before alighting to feed.

A source of water with a relatively bare bank is attractive to doves, who generally drink after feeding. A source of grit - small pebbles used to grind seeds in the birds' gizzard, should be located near the managed fields. Doves roost near the fields during the day and move to heavy coniferous trees for nocturnal roosting. Providing good roosting cover enhances the effectiveness of any dove management efforts.

3. Hunting Program

Fall hunting has not shown to affect the next year's breeding population. Early season shooting often crops the local breeding birds, who quickly move to undisturbed fields to feed. Hunting should be restricted to several alternate days a week with only a few hours of shooting a day permitted for a managed dove field to stay productive any length of time. Shooting should be rotated amongst fields to insure holding doves on the area. Late afternoon shooting at water holes and early evening shooting near roosts disperse the birds and encourage redistribution to neighboring fields.

4. Hunting Program Recommendations

a. Begin placing nesting cones where deemed necessary and feasible.

b. Continue to plant fields to attract doves for the purpose of a hunting program. Increase disking near dove fields. Add ponds with bare banks where possible.

c. Develop strategies for increasing late season dove hunting opportunities.

d. Develop guidelines for decreasing hunter pressure in the first part of the season. Consider rotating fields, limiting hunter density, restricting shooting hours.

GOAL: PROVIDE MORE HUNTING OPPORTUNITIES IN LATE DOVE SEASON.

I. Small Game Hunting Program

Small game densities are sufficient to support a hunting program on Nanticoke. Bobwhite densities are stable and probably near carrying capacity for the existing habitat. Cottontails are abundant but need more nesting and feeding cover. Gray squirrels are plentiful in the areas with good mast production, but limited in pure loblolly or Virginia pine stands.

Clean farming and an expanding residential human population in Sussex County will create an imbalance between a demand for and the supply of rabbits and quail. This situation will inevitably bring more small game hunters to the Area. Small game densities are insufficient to support an increased demand for quail and rabbit hunting opportunities. Any attempts to increase quail and rabbit numbers will involve increased edge probably as a result of a timber sale. The

potential for timber harvesting is good, but the dry soils suitable for timber sales are poor for establishing additional wildlife food and cover plots.

No records of the number of hunters or the small game they harvest exists for Nanticoke. No permits to hunt are required on Nanticoke primarily because no means of distributing or collecting the permits exists. When a checking station is developed for deer, a small game hunting permit program will be instituted.

J. Waterfowl

1. Habitat Needs

a. Food habits

Dabbling ducks feed in water up to 18 inches depth by thrusting their heads under the water. "Tipping up" refers to the sight of ducks inverted in the water with only their tails showing. They also feed by skimming seeds from the water surface or pulling food material from the emergent vegetation. Their diets consist of vegetable and animal material found in this habitat. Animal matter, largely invertebrates, provides protein for nesting hens and ducklings.

Plant materials from duckweed to acorns make up 90% of the wood duck's diet. Insects and spiders compose the remaining 10%. Persistent overwintering fruits or early appearing plants and invertebrates are essential for the nesting wood duck (Aix sponsa) hen's high protein requirements. Insects are taken primarily during and after the nesting season and by ducklings during the first few months of life.

Wood ducks feed in quiet, flooded brushy areas. They require a nearby flooded area with trees shrubs, or emergent vegetation covering 50 % of the surface of the flooded area. Water depths from 3 inches to 3 feet with a relatively low flow velocity (<3 miles per hour) are needed for feeding.

Marshes with a 1:1 ratio of plants and open water are thought to provide ideal waterfowl habitat interspersion. This interspersion puts escape and resting cover close to feeding and nesting cover. Wave action and wind velocity are diminished in emergent plant stands. Aquatic insects and submersed plants are more available in water with good clarity. An even balance of plants and open water helps reduce wave action and the resultant turbidity.

b. Nesting and brood habitat.

Loafing areas are important to ducks as they spend a majority of their time resting, sunning themselves, and preening. Mud flats, hummocks, small islands with low cover, and floating logs are used for loafing. Good loafing sites afford an unobstructed view of the surroundings to thwart a predator's approach while providing protection from wind and wave action.

Wood ducks nest on the Nanticoke Wildlife Area. Wood ducks nest in natural nest cavities and artificial nesting structures. Nesting cavities or are the prime limiting factor of wood duck

populations. There should be a minimum of one usable cavity per 5 acres located within one half mile of water.

A wood duck's clutch size is normally 10 -15 eggs, which are incubated about 28 days. Several hens will sometimes lay eggs in the same box, often leaving one hen to incubate as many as 30 -40 eggs. These "dump nests" are usually unsuccessful due to the lone hens' inability to incubate a large number of eggs. Dump nests are often a sign that the boxes are too close together and not affording the hen enough privacy.

Assuming the wood duck hen lays one egg per day until the clutch is complete, the earliest egg laying date at Nanticoke is March 20th. The earliest fledging date would have been April 17th.

Open nesting species of Puddle ducks, like the mallard and black ducks, nest within 150 feet of water in heavy vegetative cover. Aquatic invertebrate densities must be high to provide animal protein for rapid duckling growth and the hen's nesting vigor.

The hen mallard begins incubating the eggs when the clutch is complete (one egg laid per day) and hatching occurs 26-28 days later. Ducklings leave the nest at hatching and can catch invertebrates within a few hours.

Black ducks take 3-4 days to build a nest, then lay one egg per day until the clutch is complete . Clutch size averages 9 eggs. Egg laying peaks from April 12-25 and the earliest egg date in Maryland is March 19 (Bellrose 1942). Back dating from the time the first black duck brood was seen at the Assawoman Wildlife Area near Bethany Beach, Delaware, indicates that the earliest egg date was March 23. Nanticoke nesting attempts should fall within this general time frame.

Mallards nest later with peak laying occurring between May 5-20 (Bellrose 1942). The first brood seen at Assawoman in 1986 was on May 25. Using a 28 day incubation period and 9 days for egg laying, the estimated first egg was laid April 18 or roughly 26 days after the first black duck clutch. Laying dates at Nanticoke should be reasonably close to those at Assawoman.

Although Nanticoke is within the known breeding range of these two species, I have no knowledge of confirmed nesting attempts by mallards and black ducks along this part of the watershed.

Brood rearing habitat requirements differ from breeding habitat requirements. Brood habitat for wood ducks and the other open nesting species are somewhat similar. Habitat must have emergent vegetation and/or wooded shorelines for ducklings to escape danger and insect/invertebrate densities must be high to provide protein for proper body development.

Brood habitat for open nesters like Blacks and Mallards should be over an acre and have at least 5 inches of water. The ideal 1:1 plant to open water is still important in brood habitat, although heavy escape cover must be present.

Wood Ducks prefer denser habitat (75/25 cover to open water), greater area (10 acres minimum) and maximum edge for good brood survival. Wood Duck broods are usually found

using backwaters with a low flow rate (< 1 mph) and dense woody stems standing in water. A cover composition of 55% emergent, 40% shrubs, and 5% trees allows horizontal movement and provides overhead protection. Water must be present through the brood season (April - July) with 75% of the water less than 3 feet deep (U. S. D. A. et al 1972).

Except during the nesting season, large flocks of Wood Ducks concentrate at night in established wooded roosts. Relatively dense, flooded vegetation, notably buttonbush, but standing and fallen timber and marshes as well, make excellent roosts. Overhead cover with water level travel avenues is ideal. Since daytime feeding areas are often 10 - 15 miles from roosts, they need not be rich in food supply.

The similarities in feeding, brood rearing, and escape cover requirements for these three species warrant an uniform approach to habitat management.

2. Habitat Management Recommendations

As part of the Blackwater-Nanticoke Focus Area in the North American Waterfowl Management Plan, the Nanticoke watershed has been identified for protection and enhancement under the Atlantic Coast Joint Venture. The riparian corridor contains critically important waterfowl habitat (Whitman 1991).

The riparian corridor along these two streams should be left undisturbed. The extensive wildrice beds across from Phillip's Landing are excellent brooding and feeding habitat for resident and migratory waterfowl. All tributaries of the Broad Creek and Nanticoke River have equally valuable waterfowl habitat. Any effort to increase the setback required by Sussex County Land Use Plan for housing along the stream should be supported. I feel a minimum of 200 feet is required to fully protect the wooded stream and river banks needed for waterfowl nesting, brooding, loafing, and feeding. Protection should be extended to the headwaters of all tributaries. The concept of a buffered "conservation zone" of 1000 feet of a stream should be supported because waterfowl nesting habitat is being lost to waterfront residential housing.

Management for resident populations of wood ducks centers around providing nesting habitat. When natural cavities are not available in sufficient densities the most common solution is to provide artificial nesting structures or wood duck nest boxes.

Artificial nesting structures properly built, placed, predator-proofed, and maintained can produce many more wood ducks per acre than natural cavities (U. S. D. A. et al 1972). Nesting structures should be 24 inches in height and 10 X 10 inches square. The hole should be 18 inches from the bottom of the structure and about 4 inches in diameter. Nesting material such as sawdust, wood shavings, or ground corncob must be provided to a depth of 3 - 5 inches. Rough cut lumber, hardware cloth, or screening must be used so the young wood ducks can climb out of the box. Holes should be drilled in the bottom of the box for drainage (Anon. 1976).

The best height for the nesting structure is 4 - 5 feet above the water or over 15 feet above the ground in upland woods, and they must be predator-proof. A 50 inch band of metal, an inverted cone shield or a metal sleeve from 38 - 50 inches wide will protect the nest and incubating hen

from raccoons, snakes, mink, and other predators. The structures should be placed singly about 100 feet (or more) apart. The boxes should be arranged to maximize privacy between boxes. They should be over water or adjacent to brood habitat and placed so they are readily visible to the ducks. Human disturbance should be kept to a minimum, particularly near the nesting structure. Areas of unused habitat are generally the result of lack of adequate nesting sites (U. S. D. A. et al 1972).

The habitat supports wood ducks and our present nest box program shows signs of improving. More boxes will be placed along Cod Creek and the unnamed tributary emptying into the Broad Creek at Phillip's Landing. Unused boxes (especially boxes hard to access) will be moved and additional boxes added.

3. Hunting Program Recommendations

Nanticoke Wildlife Area provides one of the few remaining publicly owned lands that still allow jump-shooting of waterfowl. Jump-shooting requires no equipment, save a pair of boots and a gun, and stealth. This form of hunting provides beginners and waterfowlers without the resources or desire to acquire a large set of decoys an opportunity not found elsewhere. The practice should be retained.

Another form of waterfowl hunting found on a limited basis on state wildlife areas is the opportunity to build ones "own" blind in a location of their own choosing. Blinds can be build on Nanticoke and Broad Creek for the purpose of waterfowl hunting provided the builders acknowledge that whomever enters the blind first on the day of the hunt has rights to the blind for the duration of their hunt. The materials become the property of the State and anyone is free to use these blinds built by private individuals.

No permits are required at this time. Jump-shooters stalking on foot or by boat must abide by state statute requiring that they stay 300 yards away from any occupied blind.

K. Access.

Access to the wildlife area comes from four County Roads - 487-A, 493-A, 494, and 496, each of which serve different tracts of the wildlife area. All of the county roads are paved and passable in all weather. The Division of Highways does not have any signs directing the public to the Wildlife Area, but several signs to Phillip's Landing are visible.

Phillip's Landing Road (C.R. 496) is the most heavily traveled road because two housing developments and the Phillip's Landing Fishing Area lie at its terminus. The Sharptown Road (C.R. 494) forms the southern boundary and provides access to the headquarters-shop area.

Access to the Red House Tract has changed several times and its present location was contested by Mr. O'Neal in a civil action before the Court of Chancery (Civil Action 1193 - Sussex County) on May 2, 1991. The court placed a permanent injunction from closing the road and created a 12 foot right-of-way along a dirt road called the "new" Austin Road leading from the

Bethel-Woodland Ferry Road (C.R. 487-A) into the tract. Details of the history of the road and ownership changes are stored in the files of the Acquisition and Property Manager.

The Division added gravel and graded the Red House access road to drain into a ditch in 1984 and continues to maintain the road beyond its boundaries as a gesture of "good-neighborliness".

The Division owns a 60 foot right-of-way along the north bank of the Broad Creek (1/2 mile south of the new Austin Road on C. R. 478A) leading to Bailey's Landing, but not beyond to the Red House tract (Deed # 653-8, 4/13/70). The use of this right-of-way for access to a proposed development is still under investigation by the DNREC legal office.

Sixteen and a two tenths miles of dirt road traverse the area. Much of this mileage lies along boundary roads originally made to offer fire protection. Several of the "roads" were designed as ways to increase edge and provide walking access, but became de facto roads after many years of repeated use.

The sandy soil on the roads is easily worked, but tends to wash out quickly under wet conditions and heavy vehicular use.
On a normal year the road is bladed 8-10 times a year. Pine needles accumulate on the shoulders making grading with a light blade difficult. A six foot wide landscape rake was purchased in the spring of 1990 to remove leaves and needles. The tool works well and has made the use of the blade easier. A grader is used once a year to pull the dirt back onto the road.

The area is closed each night from sunset to sunrise. In 1987 three interior access roads were closed with steel gates to control access, reduce litter, and improve use of the openings and edges by wildlife. Each road has a locked gate at one end and two Jersey barriers at the opposite end for permanent closure. More gates and barriers were added since 1987 to bring the total to 7. One gate leading to both the Davis property called "Furbush" and part of the Henry Tract south of Broad Creek was built and installed (late summer of 1989) by the Davis family using materials paid for by the Division. Each party has a key to the gate.

Two major interior access roads traverse the Henry Tract, both connecting the Sharptown and Phillip's Landing Roads. The roads which formerly connected these two roads are now closed to unauthorized vehicles. All of the closed roads are open to pedestrians at all times. A horse riding club regularly uses the closed roads for trail riding. Strict interpretation of State Wildlife Area regulations would preclude horses from any road closed to motor vehicles. This regulation has not been enforced.

Gates on the Henry/Hasting Tract are regularly vandalized. Numerous locks have been shot off, signs removed, and the cross members bent. A heavy duty metal gate was designed and installed, and damages have declined since 1988 when a metal box was built around each of the locks. The cost of cleaning up litter, gate repair, loss of timber to theft, and the harassment of wildlife justify the expense of road closure. This policy should be enforced rigorously.

The Phillip's Landing Recreation Area provides boating access to the Nanticoke River and Broad Creek. Two boat ramps and a floating "courtesy pier", several concrete picnic tables, trash barrels, and a portable toilet are located at the fishing area. Parking spaces for 50 vehicles with boat and trailer are available. The fishing area is maintained by the Fisheries staff, who are stationed at the shop on the Wildlife Area.

Area maps are available to the public at the main entrance beside the bulletin board off Sharptown Road. A copy is posted in the bulletin board display as well.

L. Closed Areas.

1. Roads

The only closed areas on Nanticoke Wildlife Area occur on the interior roads closed to vehicles. These areas were closed to reduce litter and minimize disturbance to wildlife using the wildlife food and cover plots located along these access roads. Since road closures began in 1987 wildlife use has increased in the food plots. Deer stands have been installed in the food plots which previously received very little deer use due to repeated day and night time vehicular use.

2. Target shooting

Several gates were damaged by rifle and handgun fire when they were used as backstops by "target-shooters". The fact that target shooting occurs in spite of a prohibition on firearms on the wildlife areas from March 1 - August 31 indicates at least some local interest. At one time the Division agreed to allow target shooting on Nanticoke and an earthen backstop was erected in the dirt pit area of Field 4. A Division employee was assigned to provide access on weekends when a request was made. However interest in target shooting waned and the area was closed off in 1987. Since that time no one has asked for a shooting area.

If a shooting area is needed and desirable, the Division must examine it's liability responsibilities first. Erecting a dirt mound and designating the area as a target shooting area without proper supervision, access control, and other proper safety precautions invites a lawsuit from an injured party. "Unoffically" allowing shooting on the Wildlife Areas makes a mockery of our Hunter Safety Program, Wildlife Area Rules, and our stated policy of road closure to enhance wildlife use of the Wildlife Areas. Many of the "new" non-traditional users of Wildlife Areas already fear for their safety during the legal hunting seasons. Adding another source of noise and danger will only drive these potential supporters away. Instead of condoning "plinking" in the local dirt pit, we should be moving aggressively towards another high quality shooting range.

I recommend that the Division set the long-term goal of developing a multi-activity shooting range in central Sussex County (the Lang Tract near Redden State Forest has strong possibilities) which compares with Ommelanden in New Castle. If temporary shooting ranges are desired on the Wildlife Area it should be built to National Rifle Association standards. Special care should be taken not to let these temporary ranges become de facto permanent ranges. The funding should be committed early in the process. Until a range is developed shooters should be directed to

local shooting clubs such as the Nanticoke Sportsmen Club. Perhaps the Division could underwrite the cost of opening the range to the public on specified days.

M. Wetland Creation Projects

As part of the ongoing Wetland Improvement Projects in State Wildlife Areas Program an inventory of potential wetlands improvement projects will be generated. Nanticoke has several potential sites to create ponds or enhance wetlands. One potential project is creating a shallow pond within a portion of a wet wildlife food and cover plot in the George Adam's Field (2B).

This particular field has been a source of trouble for the past five years. Each year in late spring the field appears to dry out. The surface soil is dry and dusty allowing us to mow or disk with light tractors. When a heavier piece of equipment such as a fertilizer truck or a tractor crosses the spot they become stuck. The ground seems to retain sub-surface water creating a "quick-sand"-like situation. The area is approximately 2 acres in size on the back of a large secluded field. A shallow emergent wetland pond would greatly enhance the field's wildlife suitability. The conversion of a wet cultivated field to an undisturbed wetland would reduce farming and equipment costs as well.

Another potential site for a wetland project occurs along the eastern boundary road on the Henry/Hasting Tract where a poorly maintained hand-dug ditch designed to drain a wet woods routinely overflows into the road. A liability could be changed to an asset by allowing the water to collect on both sides of the road, establishing an equilibrium between the water levels with a culvert and raising the road bed with fill.

A third site occurs at the oldest borrow pit on the Area. The pit is located in a dry woods along a road recently closed to vehicular travel and within a short distance of Fields 11 - 13. One fourth of the pit bottom holds water for the duration of the summer. If the bottom were excavated and the slopes re-shaped to a less severe gradient, an improved amphibian breeding site and source of water for upland species would be created. Any fill could be stockpiled for road work.

A second abandoned borrow pit (approx. 5 acres) along the Phippinsville Road (C. R. 493A) could be excavated to allow tidal influx from the Broad Creek. Spawning habitat for largemouth bass might be created this way.

Funding from outside the agency is available through the initiative of the North American Waterfowl Management Plan administered by the U. S. Fish and Wildlife Service for the creation of wetlands. This funding mechanism should be explored for these four sites.

IX. WILDLIFE SURVEYS AND INVENTORIES

A detailed record of animal and plant surveys is useful to document the results of existing wildlife management practices, highlight the need for corrective actions, to protect past practices,

and provide continuity in the event of personnel changes. A discussion of the surveys and inventories used on Nanticoke follows.

A. Nest Box Surveys

1. Wood Duck

Fourteen Wood Duck boxes were placed along Broad Creek, the Nanticoke River, and several small tributaries of each stream in the February and March 1986. Two more boxes were added in 1987. One box (#14) was used in 1986 - along the small stream that runs under the Phillip's Landing Road just before the parking area (Appendix 6). The same box was used in 1987 and 1988. Two clutches fledged in 1987 and one clutch in 1988. No other boxes were used by Wood Ducks in 1986, 1987, or 1988 (Table 5). Starlings were removed twice in all three years. A Prothonotary Warbler (Protonotaria citrea) used a box near Phillip's Landing. Four warbler nestlings were discovered on July 1, 1987.

In March 1991 three boxes were moved to Cod Creek and another added up a tributary near Phillip's Landing Recreation Area. This is the first year we have tried the plastic "Bellrose" boxes distributed by Ducks Unlimited.

The boxes should be cleaned, repaired, and have litter replaced in early February each year. I recommend that Wood Duck Boxes be checked weekly starting April 1st and continued until June 15. A sample of the nest box survey form is in the appendix (Appendix 7). Starling nests, eggs, and young should be removed each time they are found. No more boxes will be erected (except replacements) until a minimum of 25 % of the boxes is occupied. Boxes unused for three consecutive years can be moved to areas of use.

Table 5. Wood Duck nest box census- # of boxes used, eggs or membranes, 2nd clutches, and non-target species status. 1986 - 1990.

	# boxes	# boxes used	# eggs	# egg shell membranes	2nd clutches	# non-target species
1986	14	1	8	8	0	starlings
1987	16	1	8	8	1	prothonotary warbler
1988	16	1	11	11	0	starlings
1989	16	5	47	5?	?	
1990	16	4	19	11	?	gr. crested flycatcher
TOTAL		12	93	43?	1?	

2. Squirrel

Twelve boxes were placed along the Main Access Road prior to the 1986 squirrel nesting season. Chewed entrances, shredded leaves, nest cups, and hair indicate squirrel use and are used to determine usage. Twelve more boxes were added in the spring of 1987 for a total of 24 boxes. All 24 boxes had some litter within indicating the boxes are used for shelter, if not nursery cavities. The results of nest surveys are listed in Appendix 8. The boxes have been used in varied degree since initial construction. In 1989 no adults or young squirrels were found during a survey in May. The survey was probably done too late in the nesting season. Two litters of raccoons were found in the squirrel boxes. In 1990 eight litters were found during a March 22 survey. The litter size average was 1.25 (Appendix 8).

Squirrel boxes will be checked in March each year. The July survey will be on alternate years or during years with exceptionally low or high spring counts.

3. Bluebirds (Sialis sialis)

A bluebird trail was established within the Area in February 1988. Boxes were mounted on plastic pipes 3-5 feet from the ground and placed 15 feet from the wood's edge in fields one acre or larger. The entrances were oriented towards the fields. The boxes are at least 300 feet apart to prevent territorial responses. Boxes were checked weekly beginning May 15. A total of 14 boxes are located on the Wildlife Area. Most boxes are located in Fields 2, 3, and 4 - the three largest fields on the Area. Eastern bluebirds, house wrens (Troglodytes aedon), Carolina chickadees (Parus caroleninsis), and white-footed mice (Peromycus leucopus) have used the boxes. Old nest material will be removed to encourage re-nesting. Reproductive data will be collected and recorded on the nest box survey data form (Appendix 7).

4. Kestrel (Falco sparveius)

Kestrel nest boxes will be placed near large fields on the Wildlife Area beginning in 1991. An annual survey will be performed along with the bluebird nest box survey.

5. Bat

Bat roost boxes will be installed along riparian corridors and within wet woods near the tributaries. The boxes will be checked during the summer months.

B. Other Surveys

1. Wild Turkey

A spring gobbler count is conducted near the original release sites in the county each spring. The survey examines the rate of population change and range expansion of a flock of turkeys

released in the Cypress Swamp in 1985. Turkeys released in Maryland near Federalsburg are suspected to have wandered into Delaware as well. The survey uses three staff members for two mornings. Data from the survey will used more frequently as the birds disperse into the area.

2. Northern Bobwhite

Since the statewide spring singing male count was discontinued in 1989, no comparison data is available to evaluate the management on Nanticoke. Beginning in the fall of 1990 a pre- and post hunting season survey (October-November and March - April) will be run with trained pointing dogs. The number of coveys found, total number of birds, and locations will be recorded. It is hoped that a representative sample of birds using the food plots can be obtained.

A singing male count may be initiated in the future. A yearly and long range comparison of singing males on the wildlife area will allow the biologist to evaluate the effectiveness of the habitat manipulations.

3. Breeding Birds

A breeding bird survey will be used to track songbird densities on the area. This survey will provide baseline data valuable in predicting the effects of habitat succession and manipulation on another vertebrate population.

The survey will consist of a 20 stop route spaced at 1/4 mile intervals. At each stop all singing birds will be recorded during a five minute interval. The survey will be conducted every third summer beginning in early May 1992 and run in 3 two week intervals. The survey begins at dawn. Observations will be recorded on a cassette tape and transcribed to data sheets. The route will cover the wildlife area on both sides of Broad Creek. The results will be tabulated and analyzed and become a permanent record of the Wildlife Management Plan.

4. Muskrats

Annual trapping data from the trapping lessee harvest report for the trapping lease will be included in the plan to provide a permanent source of information on muskrat densities and population trends.

5. Osprey

Ospreys numbers have increased since the 1970's. Birds nest on navigation markers on the Nanticoke River. Although osprey nests in the Inland Bays region are checked from the air early in the nesting season to pinpoint active sites, and revisited when the nestlings are large enough to band (late June - early July), no such survey is made on the Nanticoke watershed. The Nongame and Endangered Species Coordinator will be asked to include this region in the upcoming surveys.

6. Wildlife Food and Cover Plots

A survey was initiated in January 1986 to study the utilization and effectiveness of the food and cover plots. The design of the study was rather simple. A person walked the length of the plot and observed what animals flushed and also deduced what animals used the plot by noting what animal sign was present. Notes were kept on species, behavior, number, method of determining use (seen, heard or deduced from sign), and what crops were being used. Although available personnel are not well trained in wildlife identification, preliminary results of this survey have been used to evaluate the usefulness of a particular plot, crop, or cover/crop combinations. A survey form is included in the appendix (Appendix 9).

7. Deer Spotlight Counts

Trends in deer densities will be monitored using a spotlight count. Four people in a pickup truck - two spotters, a recorder, and a driver, will begin one hour after sunset and drive the roads and fields searching for deer with a spotlight. A survey form is included in the appendix (Appendix 10). Counts will be done at least twice a year - before the regular shotgun season and after the last firearms season in January. If time and manpower permit, more counts will be done. I should emphasis that this spotlight count will give us trend information only. Year-round counts done at the Patuxent River Naval Air Station (2000 acres) required a minimum of 35 counts to obtain estimates within a 95 % confidence level (Rambo 1990).

C. Habitat Inventories

1. Wildlife Food and Cover Plot Management

Written records of food plot management practices describing the chronology of plantings and treatments were started in 1986. Staff members were asked to recall what was planted in each plot as far back as they could remember. The information was used to establish crop rotations and plan future crops.

Records of the time of fertilizing, plowing, disking, planting, mowing, and burning are logged in the Food Plot History Form. Seeding and fertilizing rates are recorded to evaluate soil fertility and crop suitability on each plot. A sample data form is included in the appendix (Appendix 11).

2. Burning and Spraying Records

Burns are done in the cool, wet days of late winter and timing can be critical in achieving desired plant response. The effects of prescribed burns on food and cover plots, woods, and marsh vegetation will be recorded to help plan future habitat manipulations.

3. Forest Management Plan

The recommendations of the Delaware State Forest Service in the form of a Forestry Management Plan will be included with this plan upon its completion. The forest management plan will include a timber cruise which describes the forest by forest type, relative species composition,

timber volume and market value. Using these surveys and economic predictions as a rough guideline, the regional biologist can integrate wildlife and forestry objectives into an acceptable format for a Wildlife Area.

4. Incidental observations

Valuable data on species abundance and distribution on the Area can be gathered incidental to other activities. Field personnel can turn casual sightings into valuable management tools by using a general observation record system. This form is found in the appendix (Appendix 12).

X. MEASURES FOR TESTING THE EFFECTIVENESS OF THE PLAN.

A. Introduction

Aldo Leopold, considered the " father of wildlife management", described the field of wildlife management as the art and science of producing wildlife for the needs of man and animal. Wildlife populations are cyclic and both density independent and dependent - that is affected by both the environment and the actions of members of their own kind. This dynamic relationship often makes density calculations "relative' in terms of time and space rather than an absolute estimate. Testing the effectiveness of a habitat manipulation on an animal population is never a simple exercise in "cause and effect". Often the wildlife manager uses generalized techniques to achieve a balance between plant and animal communities. Balancing the food and cover requirements of several species into an integrated wildlife management plan requires the wildlife manager to use not only proven techniques but also imagination and intuition.

There are many means for increasing plant interspersion and diversity within a field. Each planting, mowing, or burn affects plants differently. Some grasses seed heavily after a mowing, others respond to burning. Efforts to increase interspersion of plant communities may help one animal species while hindering another. A mowed strip might encourage the re-growth of succulent greens beneficial for rabbits, but disturb a nesting Bobwhite. Testing a wildlife management technique is often a qualitative procedure and a matter of weighing the needs of one species with the competing requirements of another species. The following description lists some measures employed as "indicators" of success.

B. Hunter Mail Survey

Harvest data for upland game species, waterfowl and deer can provide valuable data for managing the populations on Nanticoke. The Statewide Hunter Mail Survey has too small a sample size and relies too much on the hunter's memory to have much value as a predictive tool to evaluate habitat and population management on a Wildlife Area.

The hunter mail survey is a useful tool to evaluate hunter demographics, attitudes, economics, and satisfaction with the hunt, but should not be used to measure animal population

trends. The survey would be more useful if selected hunters were notified before the sampling period. The hunter could then keep an accurate and complete journal of his/her activities.

C. Permit System

A permit system similar to Assawoman's would greatly improve our ability to affect animal and plant populations through our management techniques.

D. Surveys and Inventories

The following list of surveys and inventories has previously been described. They will be used to measure the effectiveness of the proposed management plan.

1. Nest box checks for wood duck, squirrel, and bluebirds.
2. Surveys of wildlife food and cover plots.
3. Records of wildlife food and cover plot history.
4. Records of prescribed burning and spraying.
5. Survey of the breeding bird populations of Nanticoke.
6. Survey of breeding amphibian and reptiles.

E. User Survey

Two measures of the effectiveness of the area wildlife management practices are the number of people using the area and their level of satisfaction. Nanticoke attracts people interested in both wildlife and fisheries recreational opportunities (although at different times of the year). A meaningful user survey must be designed to sample all participants.

A two part survey is proposed. Hunters will be surveyed at the proposed checking station (or by a window survey). The surveys will be distributed with the permits. The nonconsumptive public, i.e., people using the fishing areas, will be surveyed by distributing the survey at Phillip's Landing. A seasonal employee might be retained to handle weekend surveys. The results of the survey could be included within the plan or a public meeting called to discuss the alternatives. A suggestion box placed near the entrance might be another effective way to measure the level of satisfaction of the public with management practices.

The number of hunters using the area is basically unknown with the exception of data from the hunter mail survey. My feeling is that demand is moderate for all types of upland hunting and minimal for waterfowl hunting opportunities. The survey may be able to determine if the area is being used because the hunters prefer hunting here or whether the lack of good wildlife habitat and poor access to private land has forced them to use public hunting areas.

XI. PROVISIONS FOR COMPLIANCE CHECKS

A. Law Enforcement Checks

Effective management of wildlife populations depends on good law enforcement. State Wildlife Areas should be a model of good wildlife management for landowners to emulate. If hunters believe there is a reasonable chance of apprehension for game law violations, scofflaws will be deterred.

There seems to be an underlying assumption on the part of Enforcement Agents that the people who use State Wildlife Areas generally comply with the regulations. I think they are correct, but should infrequent enforcement field checks on State Wildlife Areas change the the perception amongst wildlife area users that they are likely to be checked, compliance can (and will given the nature of the hunting program at Nanticoke) deteriorate rapidly. Resident biologists have been cross-trained in law enforcement and may prove effective in providing this deterrence. However, both enforcement agents and biologists need to work together more in and out of the hunting season.

B. Biological Monitoring

Biological and law enforcement objectives would be accomplished with an improved game check system. If hunters believed that the animals they harvested would be checked, they would be less likely to exceed the bag limits. On-site deer checking provides another deterrent and improves biological data collection. Better trained wildlife personnel could check animals harvested on the area for positive identification, sex and age, and condition.

Habitat manipulations will be monitored on a long term basis by evaluating and revising the plans for burning, permanent clearings, hedges, timber reforestation, and freshwater wetland enhancement projects. The success or failure of a particular food and cover plot planting will be documented each year. Soil fertility, weed and pest control programs will be monitored on a five year cycle. Animal surveys such as the breeding bird survey, food plot survey, quail covey count, turkey call counts, and waterfowl production estimates, e.g., brood counts and nest box data will become a permanent file in the plan. A forestry plan will be developed by the State Forestry Service and included in the plan.

C. Periodic Review of the Wildlife Management Plan

The wildlife management plan will be reviewed and revised, if necessary, every five years. Public involvement will be encouraged through periodic review by the Fish and Game Advisory Council and revisions by the Division of Fish and Wildlife. The plan will become a "living document" by adding current information and storing survey results within the appendix of the plan.

Statewide plans for critical species and habitats are needed to augment the individual area plans. Wildlife areas should be managed as representatives of an ecosystem, however, the objectives of the area plan should be subordinate to the goals of an ecosystem management plan. If, for example, a statewide plan for the endangered Delmarva fox squirrel identified optimal habitat types not found on the wildlife area, the area habitat management objectives would be modified to conform with the statewide plan.

XII. SPECIAL EQUIPMENT NEEDED

A. Checking Station

A checking station will be needed if a permit system is instituted. The station should be built slightly bigger than the Assawoman Check Station as it might serve as a two person checking station for the firearms deer season.

B. Residence

Adding a house to the area would greatly enhance the security and protect management projects. This area is large enough and remote enough to warrant a permanent house and on-site personnel. The new housing would also provide an additional incentive to attract and retain quality personnel.

XIII. BUDGET

Funding to operate the Nanticoke Wildlife Area comes from various sources. The majority of funds are federal aid monies derived from the Pittman-Robertson Wildlife Restoration in Aid Act Fund. The Federal Government supplies 75 % of the funds which is derived from a 11 % excise tax on sporting goods. The Division matches the other 25 % with its own money and resources. The P-R project which pays for the actual operation of the Wildlife Area is called W5D. W5D pays for the acquisition and maintenance of the following items on Nanticoke: 1 headquarters (shop), 1 storage shed (pole barn), 7 vehicular bridges, 16.2 miles of road, 500 feet of chain-link fence, 20 deer stands, 2 parking lots, 2 boat ramps, 3 Area signs, 150 boundary signs, 60 acres of food plots, 50 acres of mechanical habitat manipulations, 5 acres of chemical vegetation control, 15 acres of controlled burning, and 60 nest boxes. Endangered species work is funded with a project called E1. Any work done on the fishing areas is paid through a fund called F2D.

Appendix

Appendix 1. Checklist of mammals, birds, reptiles, and amphibians likely to occur at Nanticoke.

KEY TO ABBREVIATIONS

WHEN

YR - Year-round resident.
SFM - Spring or fall migrant
W - Winters only
S - Summers only
? - Unknown

ABUNDANCE

C - Common
U - Uncommon
R - Rare
E - Endangered
T - Threatened
? - Unknown

MAMMALS

SPECIES	PRESENT	WHEN	ABUNDANCE
WHITE-TAILED DEER	YES	YR	C
GRAY SQUIRREL	YES	YR	C
EASTERN COTTONTAIL	YES	YR	C
RACCOON	YES	YR	C
OPOSSUM	YES	YR	C
STRIPED SKUNK	?		
RED FOX	YES	YR	C
GRAY FOX	?		
RIVER OTTER	YES	YR	C
MUSKRAT	YES	YR	C
LEAST WEASEL	?		
WOODCHUCK	NO		
BEAVER	NO		
SHORT-TAILED SHREW	?		
MEADOW VOLE	YES	YR	C
STAR-NOSED MOLE	?		
EASTERN MOLE	YES	YR	?
MASKED SHREW	YES	YR	?
WHITE-FOOTED MOUSE	YES	YR	
DEER MOUSE	?		
WOODLAND JUMPING MOUSE	?		
DELMARVA FOX SQUIRREL	YES	YR	RE
RED SQUIRREL	NO		
SOUTHERN FLYING SQUIRREL	YES	YR	?
MINK	?		

SHORT-TAILED WEASEL	?		
COTTON RATS	YES	YR	?
SPERM WHALE	NO	?	E
BLUE WHALE	NO	?	E
FINBACK WHALE	NO	?	E
SEI WHALE	NO	?	E
HUMPBACK WHALE	NO	?	E
RIGHT WHALE	NO	?	E

BIRDS

BOBWHITE	YES	YR	C
RING-NECKED PHEASANT	NO		
WILD TURKEY	NO		
MOURNING DOVE	YES	YR	C
PIED-BILLED GREBE	YES	W	U
AMERICAN BITTERN	YES	SFM	U
LEAST BITTERN	NO		
GREAT BLUE HERON	YES	YR	C
GREAT EGRET	YES	S/SFM	U
SNOWY EGRET	YES	S/SFM	C
GREEN-BACKED HERON	YES	YR	C
BLACK-CROWNED HERON	YES	SFM	R
YELLOW-CROWNED HERON	YES	SFM	U
GLOSSY IBIS	YES	S/SFM	U
TUNDRA SWAN	YES	W/SFM	U
MUTE SWAN	YES	SFM/YR	U
CANADA GOOSE	YES	W/SFM/YR	C
SNOW GOOSE	YES	W	C
WOOD DUCK	YES	SFM	U
AMERICAN BLACK DUCK	YES	YR/SFM/W	C
MALLARD	YES	YR/SFM/W	C
BLUE-WINGED DUCK	YES	SFM	R
GREEN-WINGED DUCK	YES	SFM	C
GADWALL	YES	SFM	U
NORTHERN PINTAIL	YES	SFM	C
SHOVELER	YES	SFM	U
AMERICAN WIDGEON	YES	SFM	U
RUDDY DUCK	YES	SFM/W	C
CANVASBACK	YES	SFM/W	C
REDHEAD	NO		
RINGNECK	YES	SFM/W	U
GREATER SCAUP	YES	SFM/W	C
LESSER SCAUP	YES	SFM/W	U
BUFFLEHEAD	YES	SFM/W	C
GOLDENEYE	YES	SFM/W	U

COMMON MERGANSER	YES	SFM/W	C
HOODED MERGANSER	YES	SFM	U
RED-BREASTED MERGANSER	YES	SFM/W	U
OLDSQUAW	NO		
BLACK SCOTER	YES	SFM	R
SURF SCOTER	NO		
WHITE-WINGED SCOTER	NO		
ATLANTIC BRANT	YES	SFM/W	U
BLACK VULTURE	YES	SFM/W	C
TURKEY VULTURE	YES	YR	C
BALD EAGLE	NO	S/SFM	E
OSPREY	YES	S/SFM	C
NORTHERN HARRIER	YES	SFM/W	C
RED-SHOULDERED HAWK	YES	SFM	
RED-TAILED HAWK	YES	YR	C
BROAD-WINGED HAWK	YES	SFM	U
AMERICAN KESTREL	YES	YR	C
MERLIN	YES	SFM	?
PEREGRINE FALCON	?	S/SFM	E
SHARP-SHINNED HAWK	YES	SFM/YR	C
COOPER'S HAWK	YES	SFM	?
GOSHAWK	NO		
BLACK RAIL	?		
CLAPPER RAIL	NO		
KING RAIL	?		
VIRGINIA RAIL	YES	SFM	?
SORA	?		
COMMON MOORHEN	?		
AMERICAN COOT	YES	SFM	U
PIPING PLOVER	?	S	E
KILLDEER	YES	YR	C
AMERICAN OYSTERCATCHER	NO	SFM	R
BLACK-NECKED STILT	NO		
WILLET	NO		
SPOTTED SANDPIPER	YES	SFM	C
AMERICAN WOODCOCK	YES	SFM/W	U
LAUGHING GULL	YES	YR	C
HERRING GULL	YES	SFM/W	U
RING-BILLED GULL	YES	YR	C
GULL-BILLED TERN	?		
COMMON TERN	?		
FORSTER'S TERN	?		
LEAST TERN	?		
BLACK SKIMMER	?		
ROCK DOVE	YES	YR	C
BLACK-BILLED CUCKOO	?		

YELLOW-BILLED CUCKOO	YES	S	C
COMMON BARN OWL	?		
EASTERN SCREECH OWL	YES	YR	C
GREAT HORNED OWL	YES	YR	C
BARRED OWL	?		
COMMON NIGHTHAWK	YES	S	C
CHUCK-WILL'S WIDOW	YES	S	C
WHIP-POOR WILL	YES	S	C
CHIMNEY SWIFT	YES	S	C
RUBY-TH. HUMMINGBIRD	YES	S	C
BELTED KINGFISHER	YES	S	C
RED-HEADED WOODPECKER	YES	W	U
RED-BELLIED WOODPECKER	YES	YR	C
DOWNY WOODPECKER	YES	YR	C
HAIRY WOODPECKER	YES	YR	C
NORTHERN FLICKER	YES	YR	C
PILEATED WOODPECKER	YES	YR	U
EASTERN WOOD PEWEE	YES	S	C
ACADIAN FLYCATCHER	YES	SFM	U
WILLOW FLYCATCHER	?		
LEAST FLYCATCHER	YES	S	U
EASTERN PHOEBE	YES	S	U
GREAT CRESTED FLYCATCHER	YES	S	C
EASTERN KINGBIRD	YES	S	C
HORNED LARK	YES	SFM	C
PURPLE MARTIN	YES	S	C
TREE SWALLOW	YES	SFM	C
N. ROUGH-WINGED SWALLOW	?		
BANK SWALLOW	?		
BARN SWALLOW	YES	S	C
BLUE JAY	YES	YR	C
AMERICAN CROW	YES	YR	C
FISH CROW	?		
CAROLINA CHICKADEE	YES	YR	C
TUFTED TITMOUSE	YES	YR	C
WHITE-BREASTED NUTHATCH	YES	S	U
BROWN-HEADED NUTHATCH	?	S	U
RED-BREASTED NUTHATCH	?		
CAROLINA WREN	YES	YR	C
HOUSE WREN	YES	S	C
SEDGE WREN	?		
MARSH WREN	?		
BLUE-GRAY FLYCATCHER	YES	SFM	U
EASTERN BLUEBIRD	YES	YR	U
VEERY	YES	SFM	C
WOOD THRUSH	YES	S	C

AMERICAN ROBIN	YES	YR	C
GRAY CATBIRD	YES	S	C
NORTHERN MOCKINGBIRD	YES	S	U
BROWN THRASHER	YES	S	C
CEDAR WAXWING	?		
EUROPEAN STARLING	YES	YR	C
WHITE-EYED VIREO	YES	S	C
YELLOW-THROATED VIREO	?		
WARBLING VIREO	?		
RED-EYED VIREO	YES	S	C
BLUE-WINGED WARBLER	?		
NORTHERN PARULA	?		
YELLOW WARBLER	?		
CHESTNUT-SIDED WARBLER	?		
YELLOW-THROATED WARBLER	?		
PINE WARBLER	?		
PRAIRIE WARBLER	?		
CERULEAN WARBLER	?		
BLACK AND WHITE WARBLER	YES	SFM	C
AMERICAN REDSTART	?		
PROTHONOTARY WARBLER	YES	S	C
WORM-EATING WARBLER	?		
SWAINSON'S WARBLER	?		
OVENBIRD	YES	SFM	C
LOUISIANA WATERTHRUSH	?		
NORTHERN WATERTHRUSH	YES	SFM	U
KENTUCKY WARBLER	NO	SFM	U
COMMON YELLOWTHROAT	YES	S	C
HOODED WARBLER	?		
YELLOW-BREASTED CHAT	?		
SUMMER TANAGER	YES	S	C
SCARLET TANAGER	?	S	C
NORTHERN CARDINAL	YES	YR	C
BLUE GROSBEAK	YES	S	C
INDIGO BUNTING	YES	S	C
RUFOUS-SIDED TOWHEE	YES	YR	C
CHIPPING SPARROW	YES	YR	C
FIELD SPARROW	YES	YR	U
VESPER SPARROW	?		
GRASSHOPPER SPARROW	?		
HENSLOW'S SPARROW	?		
SHARP-TAILED SPARROW	NO		
SEASIDE SPARROW	NO		
SONG SPARROW	YES	YR	C
SWAMP SPARROW	YES	YR	U
RED-WINGED BLACKBIRD	YES	YR	C

EASTERN MEADOWLARK	YES	W	C
BOAT-TAILED GRACKLE	YES	S	C
COMMON GRACKLE	YES	YR	C
BROWN-HEADED COWBIRD	YES	YR	C
ORCHARD ORIOLE	?		
NORTHERN ORCHARD	YES	S	U
HOUSE FINCH	YES	YR	C
HOUSE SPARROW	YES	YR	C
BROWN PELICAN	NO		

REPTILES

COMMON SNAPPING TURTLE	YES		C
BOG TURTLE	?		E
WOOD "	?		R
SPOTTED "	?		
STINKPOT	?		C
EASTERN MUD "	?		
N. DIAMONDBACK TERRAPIN	NO		
EASTERN PAINTED TURTLE	YES		C
EASTERN BOX "	YES	C	
HAWKSBILL SEA TURTLE	NO		E
LEATHERBACK SEA TURTLE	NO		E
KEMP'S RIDLEY SEA TURTLE	NO		E
GREEN TURTLE	NO		T
LOGGERHEAD TURTLE	NO		T
NORTHERN FENCE LIZARD	YES		C
FIVE-LINED SKINK	?		C
BROAD-HEADED SKINK	?		
SIX-LINED RACERUNNER	?		R
NORTHERN WATER SNAKE	?		C
RED-BELLIED SNAKE	?		U
EASTERN GARTER "	YES		C
EASTERN RIBBON "	?		?
E. SMOOTH EARTH "	?		R
N. RED-BELLIED "	?		C
N. BROWN "	?		?
EASTERN HOGNOSE	YES		C
EASTERN WORM "	?		?
NORTHERN RINGNECK "	?		?
SOUTHERN " "	?		?
ROUGH GREEN "	?		?
NORTHERN BLACK RACER	?		C
BLACK RAT SNAKE	YES		C
CORN "	?		?
NORTHERN SCARLET "	?		?
EASTERN MILKSNAKE	?		C

EASTERN KINGSNAKE	?	?
NORTHERN COPPERHEAD	?	U

AMPHIBIANS

RED-SPOTTED NEWT	NO	C
EASTERN TIGER SALAMANDER	NO	E
SPOTTED "	NO	?
MARBLED "	?	?
NORTHERN DUSKY "	NO	C
EASTERN MUD "	?	?
RED-BACKED "	YES	C
FOUR-TOED "	?	?
NORTHERN TWO-LINED "	?	?
EASTERN SPADEFOOT TOAD	?	?
E. NARROWMOUTHED TOAD	?	R
AMERICAN TOAD	?	R
FOWLER'S TOAD	YES	C
SPRING PEEPER	YES	C
GREEN TREEFROG	?	U
COPE'S GRAY TREEFROG	?	E
GRAY TREEFROG	?	C
NEW JERSEY CHORUS FROG	?	R
NORTHERN CRICKET FROG	?	?
GREEN FROG	?	U
BULLFROG	YES	U
SOUTHERN LEOPARD FROG	YES	C
PICKEREL FROG	?	?
WOOD FROG	NO	?
CARPENTER FROG	NO	?

Appendix 2. Fish of the Nanticoke River - Delaware portion.

(from Nanticoke River Basin Environmental Quality Assessment Report, Del. Dept. of Natural Resources and Environmental Control, Nanticoke River Basin Working Study Working Committee, April 20, 1990, Public Review Draft, p. 20-21.).

Species	Resident Species	Sport Species	Commercial Species	Primarily Nursery	Special Status
Alewife	-	x	x	x	-
American Br.Lamprey	x	-	-	-	x
American Eel	-	-	x	x	-
American Shad	-	x	x	x	x
Atlantic Croaker	-	x	x	x	-
Atlantic Menhaden	-	-	x	x	-
Atlantic Needlefish	-	-	-	-	-
Atlantic Silverside	x	-	-	-	-
Atlantic Sturgeon	-	-	-	-	-
Banded Killifish	x	-	-	-	-
Banded Sunfish	x	-	-	-	-
Bay Anchovy	-	-	-	-	-
Black Crappie	x	x	-	-	-
Blackbanded Sunfish	x	-	-	-	-
Blueback Herring	-	x	x	x	-
Bluegill	x	x	-	-	-
Bluespotted Sunfish	x	-	-	-	-
Brown Bullhead	x	x	-	-	-
Carp	x	-	-	-	-
Chain Pickerel	x	x	-	-	-
Channel Catfish	x	x	x	-	-
Creek Chubsucker	x	-	-	-	-
Eastern Mudminnow	x	-	-	-	-
Gizzard Shad	x	-	-	-	-
Golden Shiner	x	-	-	-	-
Goldfish	x	x	-	-	-
Hickory Shad	-	x	-	x	x
Hogchoker	x	x	-	-	-
Inland Silverside	x	-	-	-	-
Ironcolor Shiner	x	-	-	-	x
Largemouth Bass	x	x	-	-	-
Longnose Gar	x	-	-	-	x
Margined Madtom	x	-	-	-	-
Mosquitofish	x	-	-	-	-
Mud Sunfish	x	-	-	-	x

Species	Species	Species	Species	Nursery	Status	
Mummichog	x	-	-	-	-	
Pirate Perch	x	-	-	-	-	
Pumpkinseed	x	-	-	-	-	
Redbreast Sunfish	x	-	-	-	-	
Redfin Pickerel	x	-	-	-	-	
Satinfin Shiner	x	-	-	-	-	
Sea Lamprey	-	-	-	-	-	
Shield Darter	x	-	-	-	x	
Shorthead Redhorse	x	-	-	-	x	
Silvery Minnow	x	-	-	-	-	
Spotfin Shiner	x	-	-	-	-	
Striped Bass	-	x	x	x	x	
Swallowtail Shiner	x	-	-	-	-	
Tadpole Madtom	x	-	-	-	-	
Tesselated Darter	x	-	-	-	-	
White Catfish	x	x	x	-	-	
White Perch	x	x	x	-	-	
Yellow Bullhead	x	-	-	-	-	
Yellow Perch	x	x	x	-	x	

Appendix 3. Crops planted in wildlife food and cover plots and acreage of individual plots 1975 - present.

Field # Crops, years, and brief description Acreage

BEHIND SHOP

1. Soybeans, corn, millet, buckwheat 1975-1982 2.9
Milo sorghum (1982-85)
Soybean, Wheat, Millet, milo, red clover (1986)
Soybean, Millet, Buckwheat (1987)
Soybean, Buckwheat, Milo, German Millet (1988 - 90)
Pasture (1990) and increased field borders

GEORGE ADAM'S

2A. Corn (1975-1977) planted in strips all over 5.8
Soybean/Buckwheat/Sunflower/Millet (1978-1985)
Soybean/Wheat/Millet/Milo/Red Clover (1986)
Milo Sorghum/Winter Wheat Sumac, Black Pine &
Bristly Locust Hedge (1987)
Sunflower/ Mix (see 1988-90 in Field #1)(1988)
Corn/Sunflower (1990)

2B. Same as 2A through 1975 - 1985 12.5
Sunflower/Milo Sorghum/Mix (see 2A 1986) (1986)
Mix - Same as 1986 plus Winter Wheat (1987)
Sunflower/Mix (see 1 in 1988) (1988-89) all strips
Corn/Sunflower/Wheat/Buckwheat/Mix - all blocks (1990)
Increased field borders

2C. Same as 2a & 2B through 1975 - 1985 10.0
Wheat/Mix (see 2A 1986) (1986)
Mix/Sorghum/Wheat (1987)
Sunflower/Mix (same as 1 in 1988) (1988-89)
Corn/Sunflower/Corn (1990)

ACROSS ROAD FROM GEORGE ADAM'S

3. Same as Field #1 1975 - 1986 2.1
Mix/Wheat (1987)
Sunflower/Mix (1988 - 89)
Mix & increased field borders (1990)

4. Same as Field #1 1975 - 1986 7.7
Sorghum/Mix/Wheat (1987)
Sunflower/Mix (1988-89)
Corn/Sunflower/Mix increased borders (1990)

NORTH END OF GEORGE ADAM'S

5. Same as Field #1 1975 - 1986) plus wheat 1.9
Mix/Wheat (1987)

Mix (1988 - 1990) Sumac/Black Pine hedge (1990)

ALONG MAIN ACCESS ROAD

6. Same as Field #1 1975 - 1986 0.6
Did not plant (1987)
Sabine Illinois Bundleflower (1988)
Mix (1989- 1990)

7. Same as Field #1 1975 - 1990 0.4

SOUTH OF PHILLIP'S LANDING ROAD

8. Same as Field #1 1975 - 1990 0.6

NEAR PHILLIP'S LANDING FISHING ACCESS AREA

9A. Soybean/Millet/Sunflower/Buckwheat (1975 - 1982) 0.6
Sorghum (1983 - 1986) Lespedeza bicolor hedge
Mix (1986 - 1990)

9B. Same as 9A - Mix (1975 - 1982) 3.6
Switchgrass border and hedge (1984)
Sorghum (1983 - 1986) Buckwheat - 2nd planting
Mix/Millet (1987)
Mix (1988 - 1990)

9C. Same as 9A & B - Mix (1975 - 1982) 0.3
Sorghum (1983 - 1985)
Not planted (1986) - drought
Mix (1987 - 1990)

9D. Same as 9 A - C - Mix 1975 - 1982) 0.4
Sorghum (1983 - 1985)
Mix (1986). Switchgrass - 2nd planting.
Not planted (1987 - 1990)

NORTH OF PHILLIP'S LANDING ROAD

10. Same as Field #1 (1975 - 1986) 0.6
Mix (1986) Switchgrass - 2nd planting
Not planted (1987 - 1989)
Mix (1990)

EAST OF MAIN ACCESS ROAD

11. Same as Field #1 (1975 - 1986) 0.5
Buckwheat (1987)
Mix (1988 - 1989)
Mix/Pasture(Tall Fesque/ K. Lespedeza/R. Clover)

12. Same as Field #11 (1975 - 1989) 0.4
Pasture (same as Field #11) (1990)

13. Same as Field #12 (1975 - 1990) 0.7

PHIPPINSVILLE(PORTSVILLE) - C.R. ROAD 493 A

14. Soybean/Millet/Sunflowers/Buckwheat (1979 - 1983) 0.8
    Milo sorghum (1984 - 1985)
    Same as Field #1 (1986 - 1990)

15. Same as Field #14 (1979 - 1983) 10 plots 5.5
    Same as Field #14 (1984 - 1985)
    Buckwheat/Mix/Switchgrass - 4 plots of grass(1986)
    Mix - 6 plots (1987 - 1990)
    Pasture - 4 plots (1988)

Total acreage 57.9

(acres planted in crops less than total acreage of food plots due to leaving edges undisturbed).

Appendix 4. Deer Stand Repair Checklist.

DEER STAND CONDITION CHECK

Wildlife Area _____

Tract _____

Employee Name _____

Date _____ 19 _____

Duck Blind/Deer Stand Number _____

Is the approach to the blind/stand free of obstructions? _____

Is the blind/stand securely anchored in the ground ? _____

Are the steps or door in good condition ? _____

Are all support boards securely fastened ? _____

Is the floor intact and sound ?_____

Are the roof and sides in disrepair ? _____

Is the blind or stand level and capable of supporting itself ?__

Is the seat secure ? _____

Is the railing secure ? _____

Are there any exposed nails ? _____

Is the stand/blind safe to use for the upcoming season ? _____

If any of the above answers are no , state here the date and
type of corrective action taken:
_____
_____
_____

Appendix 5. Wood duck nest box survey results at Nanticoke, 1986 -1990.

Box	5-15-86	4-2-87	4-6-88	5-15-89	6-1-90
1	-	-	-	-	-
2	-	-	-	-	-
3	starling	-	-	starling	-
4	"	-	-	-	wood duck - 6 eggs
5	"	-	-	-	Gr. crested fly-catcher - 4 juv.
6	"	-	-	starling	-
7	-	-	-	w.d.- 5 egg membranes	w.d. - 4 egg mem.
8	-	-	-	w.d. - 9 eggs	w.d. - 7 egg mem.
9	-	-	-	-	w.d. - 2 eggs
10	"	-	-	w.d. - 13 eggs	-
11	-	-	-	w.d. - 11 eggs	-
12	-	-	-	-	-
13	"	-	-	-	-
14	w.d. - 8 eggs *	w.d. - 8 eggs	w.d. - 11 eggs	w.d. - 9 eggs	-
15	-	-	-	-	-
16	-	prothonotary warbler - 4 nestlings (7-1-87)	-	-	-

* second clutch laid and hatched - number unknown.

Appendix 6. Nest Box Survey Form.

SPECIES WILDLIFE AREA DATE

BOX #	ANIMAL PRESENT?	# EGGS	# YOUNG	# LIVE	# DEAD	# EGG MEMBRANES	NEST MATERIAL
1							
2							
3							
4							
5							
6							
7							
8							
9							
10							
11							
12							
13							
14							
15							
16							

ADDITIONAL COMMENTS: NAME:
REPAIRS NEEDED:

Appendix 7. Gray squirrel nest box survey results 1986 - 1991.

juv. = young squirrel ad. = adult squirrel

Box	1986*	1987	1988	1989	1990	1991
1	1 juvenile 1 adult (dead)	-	-	-	-	
2	4 adults	-	-	-	-	-
3	1 juv.	2 ad./ 1 juv.	-	-	2 juv.	-
4		-	-	-	-	-
5		-	2 ad.	2 raccoons	-	1 screech owl
6		-	-	-	-	-
7		1 ad.**	1 ad.	-	-	-
8	-	-	-	-	-	-
9		-	-	-	-	-
10		-	-	-	-	-
11		1 ad.	-	-	1 juv.	3 ad.
12		1 ad.	-	-	1 juv.	1 ad.
13		-	1 ad.	-	1 juv.	3 ad.
14		-	-	-	-	-
15		-	-	-	-	-
16		1 ad./ 2 juv.	-	1 raccoon	1 juv.	1 possum
17	2 juv.	3 ad.	-	-	2 juv.	3 ad.
18	-	-	1 ad.	1 ad.	-	2 ad.
19	-	1 ad./ 2 juv.	-	-	1 juv.	-
20	1 ad./ 3 juv.	1 ad.	1 ad.	-	1 juv.	-
21		-	-	-	-	-
22		-	-	-	-	-
23		3 ad.	1 ad.	1 ad.	-	3 ad.
24	1 ad.	-	-	?	-	-
Totals	9 ad./ 7 juv.	15 ad./ 5 juv.	7 ad. 0 juv.	2 ad./ 2 coons	0 ad. 10 juv.	17 ad./ 0 juv.

*12 boxes in 1986.

** adult with juveniles but could not persuade adult to leave.

Appendix 8. Wildlife food and cover plot survey form.

WILDLIFE FOOD AND COVER PLOT SURVEY FORM

WILDLIFE AREA _____
EMPLOYEE NAME _____
DATE _____ 19 _____ TIME _____AM OR PM
WEATHER _____
TEMPERATURE _____WIND SPEED AND DIRECTION _____

PLOT #	TYPE OF ANIMAL SEEN	HOW MANY?	WHERE ON PLOT?	ANIMAL'S ACTIVITY	CROPS USED?

ADDITIONAL COMMENTS OR OBSERVATIONS _____
_____

Appendix 9. Deer Spotlight Count Survey Form.

DEER SPOTLIGHT COUNT -

LOCATION: DATE:
WEATHER CONDITIONS: SKY? WIND? TEMPERATURE?

GEN. DESCRIP. OF ROUTE:

OBSERVERS:

DEER SEEN

ADULT MALE (BUCK)	ADULT FEMALE (DOE)	JUVENILE MALE (FAWNS)	ADULT FEMALE SEX UNKNOWN (OLD ?)	JUVENILE SEX UNKNOWN (YOUNG ?)	AGE & SEX UNKNOWN

TOTALS

Appendix 10. Sample crop history of wildlife food and cover plots

1.9 ACRES ASSAWOMAN # 1 (ACROSS ROAD FROM HOUSE)

YEAR	DATES OF SOIL PREP.	SEED	SEEDING RATE	NOTES
				Soil tests taken on all fields in January 1986.
1976 - 1984		Soybean (4 yrs.), Wheat (4 yrs.).		Entire field planted. 1/4 of field on W. side in permanent grass.
1985		Soybean, buckwheat, millet, sunflower mixture.		Soybean good - 20 foot strip only.
1986	disked in early April. Dekalb Sunflower planted on 6/4/86.	Corn	19 inch rows. 6 seeds per foot. Stanford Buckwheat Broadcast 30 lbs. per acre.	plowed in mid May.

NOTES: 1985 fallow strip, 20 ft. sunflower, 20 ft. fallow, 20 ft. buckwheat, rest fallow. Buckwheat replanted on 7/2/86. 3/10 inch rain that night. Sunflower coming up sporadically. Both did well.

1987	fertilized in late April 10/10/10 - 300 #	planted 6/5 & 6/8 Essex Soybean 60 #/A German Millet 25 #/ A Buckwheat 15 #/ A Sunflower planted 6/10 in corn planter with German Millet broadcasted over at 25 #/ A.

NOTES: Dry year- soybean and buckwheat did poorly. Millet outcompeted both. Hedge planted in April with Staghorn Sumac, Japanese Black Pine, and Autumn Olive. Pines and Autumn Olive did poorly. Sumac attacked by a budworm. Sunflower should be planted earlier for dove season opener.

Appendix 11. Incidental wildlife observation form.

DELAWARE DIVISION OF FISH AND WILDLIFE

INCIDENTAL WILDLIFE OBSERVATION FORM

	DATE	SPECIES	LOCATION	NUMBER
1.				
2.				
3.				
4.				
5.				
6.				
7.				
8.				
9.				
10.				
11.				
12.				
13.				
14.				

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